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Original Article

Anaesthesia Section

Magnesium Sulphate versus Fentanyl as an Adjuvant to Levobupivacaine in Ultrasound-guided Supraclavicular Brachial Plexus Block: A Randomised Controlled Study

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ABSTRACT

Introduction: Ultrasonography (US)-guided Supraclavicular Brachial (SCB) plexus block, alone or as an adjunct to general anaesthesia, provides reliable and safe anaesthesia and analgesia for upper limb surgeries. Adjuvants improve the quality of peripheral nerve blocks by prolonging the duration of sensorimotor blocks and postoperative analgesia.

Aim: To compare Magnesium Sulphate vs Fentanyl as an adjuvant to Levobupivacaine in Ultrasound (US) guided SCB plexus block.

Materials and Methods: The present randomised controlled study was conducted at BJ Medical College and Civil Hospital, Ahmedabad, from November 2024 to July 2025, involved 62 patients aged 18-60 years, American Society of Anaesthesiologists (ASA) I-III, of either gender, posted for upper limb surgery were randomly divided into two groups: Group F and Group M. In Group F, patients received Levobupivacaine 0.5% 25 mL plus Fentanyl 50µg diluted in 5 mL Normal Saline (NS), while Group M patients received Levobupivacaine 0.5% 25 mL plus Magnesium Sulphate 250 mg diluted in 5 mL NS for US-guided SCB. The primary objective was to assess sensory and motor blockades; secondary objectives included haemodynamic parameters, postoperative analgesia, and complications, if any. Statistical analysis was done using the student t-test and chi-square test using MedCalc version 12.4.3.0.

Results: Both groups were comparable in terms of age, gender, and ASA. The onset of sensory block were early in group F (7.24±0.86) compared to group M (15.24±1.85), p<0.0001. The duration of sensory blockade was prolonged in Group M, i.e., 13.93+1.27 hours, as compared to Group F, i.e., 11.26±2.14 hours (p<0.0001), 95% CI -3.56 to -1.77, DF 60). The onset of motor block was earlier in Group F than in Group M (7.24±0.86 vs 8.20±0.82, p=0.25, 95% CI -0.99 to 0.27, DF 60). The duration of postoperative analgesia was longer in Group M as compared to Group F (15.02±1.57 vs 13.32±2.64 hours, p=0.003, 95% CI -2.80 to 0.59). No complications were observed in our study.

Conclusion: Magnesium sulphate was a better adjuvant to levobupivacaine with prolonged duration of postoperative analgesia and decreased requirements of rescue analgesia, longer duration of sensory blockade with stable haemodynamics while Fentanyl had early onset of sensory and motor block, for US-guided SCB.

Keywords: Analgesia, Motor block, Postoperative analgesia, Regional anaesthesia Sensory block

INTRODUCTION

The Brachial Plexus block, through the supraclavicular approach, is the preferred regional anaesthesia technique for surgeries involving the upper limb. At the supraclavicular level, the distal trunks and origin of the divisions of the plexus, the neural elements are tightly clustered within a compact anatomical space. This allows for uniform and rapid spread of the Local Anaesthetic (LA) solution, resulting in a dense and predictable blockade provides excellent intraoperative anaesthesia. SCB plexus block helps avoid the potential complications of general anaesthesia, including airway manipulation, postoperative nausea and vomiting, respiratory depression, and delayed recovery [1,2].

The advent of US guidance has significantly improved the precision, safety, and success rate of supraclavicular blocks. Real-time ultrasonographic visualisation allows identification of the brachial plexus, subclavian artery, pleura, and surrounding anatomical structures with clarity. Direct visualisation of the needle trajectory and the spread of the LA around the nerve bundles enhance block accuracy and minimises complications such as intravascular injection and pneumothorax [3].

Among long-acting LA, Bupivacaine has been widely used for peripheral nerve blocks because of its prolonged duration of action and reliable sensory blockade. However, cardiotoxicity and central nervous system toxicity restrict its use. Levobupivacaine, the pure S (-) enantiomer of bupivacaine, has reduced cardiotoxic and neurotoxic potential, making it particularly suitable for peripheral nerve blocks that require relatively large volumes of LA [4]. To further enhance the quality and duration of nerve blocks, various adjuvants have been added to LAs. It shortens the onset time, prolongs the duration of sensory and motor blockades, extends postoperative analgesia, and reduces the total dose requirement of LAs [1,2].

Magnesium Sulphate has gained attention as a promising adjuvant due to its antagonistic action on N-Methyl-D-Aspartate (NMDA) receptors. By inhibiting calcium influx and preventing central sensitisation, magnesium sulphate exhibits antinociceptive properties and enhances the analgesic effects of LAs. Its addition to peripheral nerve blocks has been associated with prolonged analgesia and improved block characteristics without significant systemic side-effects [1].

On the other hand, Fentanyl is a highly lipid-soluble opioid frequently used as an adjuvant in regional anaesthesia. Due to its lipophilicity, fentanyl rapidly diffuses across nerve membranes, potentially leading to a faster onset of sensory and motor blockade. It has also been shown to prolong the duration of analgesia when combined with LAs [5]. However, opioid-related adverse effects such as pruritus, nausea, vomiting, and respiratory depression must be considered when selecting fentanyl as an adjuvant. Gupta M had compared fentanyl and magnesium sulphate as an adjuvant for US-guided SCB

but they have added it to 0.375% bupivacaine [2]. This may provide adequate sensory blockade but motor block may be incomplete specially for orthopedic surgeries, so the present study evaluated magnesium sulphate as an adjuvant to levobupivacaine (0.5%) and compared its effects with those of fentanyl in US-guided SCB.

Various studies have used fentanyl and magnesium sulphate individually or compared them as adjuvants in US-guided SCB using bupivacaine as the LA [1,2,6,7]. Levobupivacaine, with a superior profile, has not been extensively studied in this context. Based on the available literature, there appear to be no studies that have evaluated fentanyl versus magnesium sulphate as adjuvants specifically with levobupivacaine in US-guided SCB. Therefore, a gap exists in identifying the more effective and safer adjuvant to levobupivacaine for US-guided SCB plexus block.

The present study aimed to identify the most effective and safest adjuvant to levobupivacaine for optimising outcomes in US-guided SCB for upper limb surgeries. The primary objective of the study was to assess the sensory and motor blockade. Secondary objectives included evaluation of the duration and quality of postoperative analgesia, monitoring of haemodynamic variables such as Heart Rate (HR) and blood pressure, and assessment of any adverse effects or complications associated with either adjuvant.

MATERIALS AND METHODS

The present randomised controlled study was conducted at BJ Medical College and Civil Hospital, Ahmedabad, Gujarat, India, from November 2024 to July 2025. Approval from the Institutional Ethics Committee (EC/NEWS/INST/2022/2401) was obtained for the study and registered with the Clinical Trials Registry of India (CTRI/2024/11/076782 dated 14-11-2024). This manuscript adheres to the applicable CONSORT (Consolidated Standards of Reporting Trials) guidelines, and the procedures were carried out in accordance with the Helsinki Declaration of 1975, as amended in 2013. Written informed consent, including the use of study data for research and educational purposes, was obtained from all participants.

Inclusion criteria: Patients aged 18-60 years, of either gender, with American Society of Anaesthesiologists (ASA) I-III, undergoing upper limb surgery under SCB were enrolled.

Exclusion criteria: Patients with head injury, distal neuro-vascular deficit, history of hypersensitivity to the study drug, patients who have already received fentanyl or magnesium sulphate, cardiac, hepatic, or renal disease and patients who do not understand the Visual Analogue Scale (VAS) score were excluded.

Sample size calculation: The sample size was calculated using the parameter "Duration of sensory blockade" from the reference study [2]. Based on previously reported mean values of 7.65±1.05 in one group and 6.27±0.94 in the other, the formula used for sample size calculation:

$$n = \frac{2\left(z_{a/2} + 2\beta\right)^2 \cdot \sigma^2}{(u_1 - \mu_2)^2}$$

Where:

Z_(α/2) = 2.576 for α = 0.01

Z_β = 2.33 for β = 0.01 (power 99%)

Pooled standard deviations $\sigma = \sqrt{\frac{SD_1^2+SD_2^2}{2}} = \frac{\sqrt{1.05+0.94^2}}{2}$

$$= \sqrt{\frac{1.1025 + 0.8836}{2}} = \frac{\sqrt{1.05^2 + 0{:}94^2}}{2}$$

$$= \sqrt{\frac{1.1025 + 0.8836}{2}} = \sqrt{0.99305} \approx 0.996$$

Substitute values $\eta = \frac{2\cdot(2.576+2.33)^2(0.996)^2}{(1.38)^2}$

$$= \frac{2(4{\cdot}906)^2 \cdot 0.992}{1{\cdot}9044}$$

$$= \frac{2{\cdot}24.07{\cdot}0.992}{1{\cdot}9044}$$

$$= \frac{4776}{1.9044} \approx 25.08$$

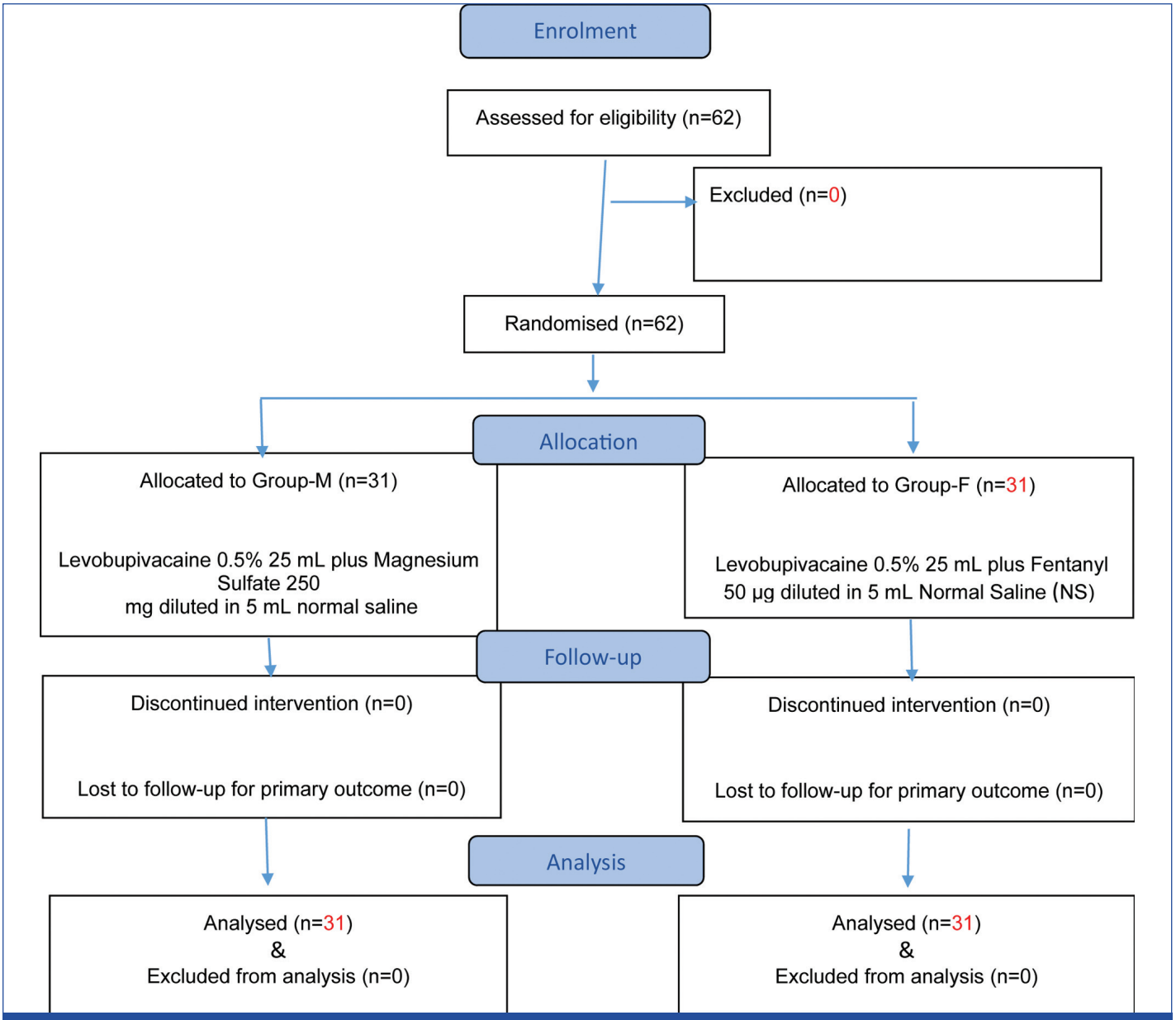
N = 26 participants per group

Given a 20% dropout rate, we studied 62 patients.

Study Procedure

Thorough pre-anaesthetic assessment and mandatory investigations were carried out. Patients were informed about the study protocol and Visual Analogue Scale (VAS). Patients were randomly divided into two groups using computer-generated random numbers (www.randomizer.org) into Group M compared with control Group F, and their allocation was sealed in an opaque envelope [Table/Fig-1]. The principal investigator generated a random allocation sequence using computer-generated randomisation. Participants were enrolled by research staff, and their allocation was done by a study coordinator who was not involved in outcome assessment. Blinding was not done here. Group M patients received Levobupivacaine 0.5% 25 mL plus Magnesium Sulphate 250 mg diluted in 5 mL NS [8]. Group F patients received Levobupivacaine 0.5% 25 mL plus fentanyl 50 µg diluted in 5 mL NS. Total volume of the drug was 30 mL [2]. Preoperatively, a nil oral status was confirmed, and an intravenous line was secured in the recovery room. In the operation theater, the multipara monitor was attached, and baseline HR, and Mean Arterial Pressure (MAP) were recorded. All patients received premedication: Intravenous Ondansetron 4 mg and Midazolam 2 mg. The patient was positioned supine with the head turned to the contralateral side, and a pillow was placed under the head to provide adequate space for the probe and the needle without compromising asepsis. A high frequency linear US probe positioned above the clavicle in the supraclavicular fossa in a coronal-oblique plane, to obtain an optimal short-axis view of the subclavian artery, first rib, pleura, and trunks and divisions of the tightly packed plexus, which are typically seen as round or oval hypoechoic structures (such as a bunch of grapes) lying postero-lateral to the subclavian artery. Local skin infiltrated with 2 mL xylocaine 2% and a 22-gauge 50 mm insulated block needle utilising the in-plane approach, was advanced from lateral to medial, maintaining needle visualisation throughout, and LA deposited either close to the angle formed at the junction of first rib and subclavian artery, or injected carefully between divisions of the plexus using a 'hydro dissection' technique. Once the needle reached the brachial plexus cluster, the drug was injected incrementally over 3-5 minutes after negative aspiration, observing the spread of the drug within the plexus sheath in real time. Where the spread did not reach some parts of the brachial plexus, the needle was repositioned once before depositing the remaining half of the LA dose [3].

Sensory block was assessed using a pinprick on a three-point scale (0=normal sensation; 1=loss of sensation of pinprick (analgesia); 2=loss of sensation to touch (anaesthesia) in the ulnar, median, radial, and musculocutaneous nerve distribution and compared with the contralateral arm as a reference. Patients were evaluated every two minutes for 10 minutes and then every five minutes up to 30 minutes after the end of the drug injection. Onset of sensory block (minutes) was considered from completion of drug administration up to Score 1 achieved in the distribution of any one of the primary nerves. Complete sensory block (minutes) was considered from the completion of drug administration to the time



[Table/Fig-1]: CONSORT 2025 flow diagram.

when score 2 was achieved in all nerve dermatomes. Total duration of sensory block (hours) was considered as duration from the end of drug administration to complete resolution of anaesthesia from distribution of all four nerves, i.e., Score 0. Motor block was evaluated by the ability to flex the elbow and hand against gravity as follows: Grade 0: no block, Grade 1: decreased motor strength with the ability to flex or extend only the fingers; Grade 2: complete motor blockade with inability to move fingers. Onset of motor block (minutes) was considered as the time from completion of drug administration to detection of a motor block of Score ≥1. Complete motor block (minutes) was considered as the time from completion of drug administration to detection of a motor block of grade 2. Total duration of motor block (hours) was considered as the time interval from the end of drug administration to the recovery of complete motor function of the hand and fingers, i.e., Score 0.

Postoperative analgesia was assessed using the VAS at 30 minutes, two hours, four hours, eight hours, 12 hours, 16 hours, 20 hours, and 24 hours. Patients were observed for the duration of postoperative analgesia (hours), i.e., from completion of surgery to VAS ≥4 or on patient demand, and the number of rescue analgesia doses required within 24 hours postoperatively. A successful block was considered a complete sensory and motor block in all nerve dermatomes assessed within 30 minutes of drug injection. In the event of a failed block after 30 minutes, general anaesthesia was administered, and the patient was excluded from data analysis.

Postoperatively, patients were shifted to the recovery room and observed for bradycardia, hypotension, respiratory distress, hypoxia, Horner's syndrome, nausea, and vomiting.

STATISTICAL ANALYSIS

Data was entered into a Microsoft Excel sheet (Microsoft Excel Office 2019). Statistical analysis was done using MedCalc, version 12.4.3.0 (MedCalc Software Ltd; Ostend, Belgium). Continuous variables were reported as mean±Standard Deviation (SD), while categorical variables were reported as frequencies and percentages. Student's t-test was employed for sensory and motor block assessment, plus duration of postoperative analgesia, and was displayed as mean±SD. Non-parametric data, such as sex and ASA grading complications, were presented as numbers or percentages, and Fisher's-exact test or the Chi-square test was used to examine them. The p-value determined significance; $p<0.05$ was considered significant.

RESULTS

All patients were studied and analysed. There were no dropouts. Both groups were comparable with respect to age, gender, and ASA [Table/Fig-2].

From [Table/Fig-3], the onset of sensory block was earlier in Group F than in Group M ($p<0.0001$). The duration of sensory blockade was prolonged in Group M (13.93+1.27 hours, ($p<0.0001$), 95% CI -3.56 to -1.77, DF 60). The onset of motor block was earlier

Variables	Group M (Mean±SD*)	Group F (Mean±SD)	p-value
Age (years)	30.05±13.25	35.6±13.3	0.194
Gender			
Male	23 (75%)	25 (80%)	0.705
Female	8 (25%)	6 (20%)	
ASA grade			
I	22 (70%)	20 (65%)	0.736
II	9 (30%)	11 (35%)	
Weight (†kg)	59.55±6.08	59.25±6.6	0.88

[Table/Fig-2]: Demographic data.
Values are presented as mean±SD or numbers. Statistical analysis: Fisher's-exact test or Pearson's Chi-square test, except for age and weight for which Student's t-test was applied. ASA: American Society of Anesthesiologists, *SD: Standard deviation, † Kilograms

Parameters		Group M (Mean ±SD)	Group F (Mean±SD)	p-value
Sensory Blockade	Onset (minutes)	15.24±1.85	7.24±0.86	<0.0001
	Complete (minutes)	19.77±1.88	17.04±2.59	<0.0001
	Duration (hours)	13.93±1.27	11.26±2.14	<0.0001
Motor Blockade	Onset (minutes)	8.20 ±0.82	7.24±0.86	0.25
	Complete (minutes)	15.24±1.85	15.19±1.5	0.90
	Duration (hours)	13.19±1.3	9.89±1.79	<0.0001

[Table/Fig-3]: Sensory and motor blockade.
Values are presented as mean±standard deviation. Statistical analysis: Student's t-test. CI: Confidence interval

in Group F than in Group M (7.24±0.86 vs 8.20±0.82, p=0.25, 95% CI -0.99 to 0.27, DF 60). Group M demonstrated significantly lower VAS scores at all-time intervals compared to Group F [Table/Fig-4]. The duration of postoperative analgesia was prolonged in Group M as compared to Group F [Table/Fig-5]. No complications were observed in this study. The HR and MAP values have been demonstrated in [Table/Fig-6,7].

VAS	Group M (Mean±SD)	Group F (Mean±SD)	p-value
30 minutes	00	00	-
2 hours	00	00	-
4 hours	0.10±0.31	1±0.97	<0.0001
8 hours	1.60±0.75	3.0±0.73	<0.0001
12 hours	2.75±0.64	4.15±0.59	<0.0001
16 hours	3.65±0.59	4.40±0.50	<0.0001
20 hours	4.20±0.41	5.10±0.45	<0.0001
24hours	4.90±0.55	5.35±0.49	0.010

[Table/Fig-4]: Visual Analogue Scale (VAS) score.
Values are presented as mean ± standard deviation. Statistical analysis: Student's t-test.

Parameters		Group M	Group F	p-value
Duration of postoperative analgesia (hours)		15.02±1.57	13.32±2.64	0.003
Number of RA	0	6 (20%)	0 (0%)	0.011
	1	25 (80%)	23 (75%)	
	2	0 (0%)	8 (25%)	

[Table/Fig-5]: Postoperative analgesia.
Values are presented as mean±standard deviation. Statistical analysis: Student's t-test, Fisher's-exact test or Pearson's Chi-square test, RA-Rescue analgesia

Heart Rate (HR)	Group M Mean±SD	Group F Mean±SD	p-value
Pre-induction	83.9 ±8.03	80.8±8.96	0.264
5 minutes	84.8±8.54	80.9±8.18	0.148
10 minutes	84.9±9.57	81.3±7.70	0.198
15 minutes	82.9±9.4	81.5±7.62	0.596
30 minutes	79.4±9.05	82.6±8.10	0.246
45 minutes	78.3±9.82	82.7±7.91	0.127
1 hour	75.7±10.7	79.7±6.70	0.178
1 hour 30 minutes	75.5±10.9	79.9±7.53	0.203
2 hour	76.3±7.78	81.5±7.76	0.202
2 hour 30 minutes	82±6.21	78.3±12.4	0.142
3 hour	83.1±0.42	82.6±1.23	0.036

[Table/Fig-6]: Heart Rate (HR) per minute.
Values are presented as mean±standard deviation

MAP	Group M Mean±SD	Group F Mean±SD	p-value
Pre-induction	89.6±7.97	89.1±6.82	0.83
5 minutes	88.9±7.81	87.7±6.68	0.62
10 minutes	87.2±8.31	85.9±7.36	0.60
15 minutes	85.9±8.23	84.8±7.11	0.65
30 minutes	85.2±8.21	83.8±7.15	0.56
45 minutes	84.6±7.58	83.2±6.46	0.53
1 hour	83.2±7.47	82.4±6.47	0.73
1 hour 30 minutes	83.3±7.01	81.06±5.54	0.30
2 hour	83.7±6.74	81±5.48	0.37
2 hour 30 minutes	80.3±6.03	77.3±6.81	0.09

[Table/Fig-7]: Mean Arterial Pressure (MAP) (mmHg).
Values are presented as mean±standard deviation

DISCUSSION

The present study showed early onset of sensory and motor blockades with Fentanyl, prolonged duration of sensory plus motor block, and postoperative analgesia with less requirement of rescue analgesia in the first 24 hours with Magnesium sulphate.

Many times SCB was performed either blindly or using a peripheral nerve stimulator, but US-guidance for SCB offers many benefits like easy access to the brachial plexus at the supraclavicular level, identifying pleura, thus minimising the risk of pneumothorax; lesser time for block performance; reducing the number of needle pricks, and avoiding accidental vascular puncture as real time visualisation of drug being injected [1,3,6-9]. Levobupivacaine is less cardiotoxic and neurotoxic than bupivacaine, while it has the same efficacy for the time to reach sensory block and total duration of sensory block as that of bupivacaine [4,10-12]. It demonstrates less vasodilation and possesses a greater length of action in comparison to bupivacaine. A favorable safety and drug effect profile for levobupivacaine confers an advantage over its racemic parent, bupivacaine [12,13]. We have used 25 mL of 0.5% levobupivacaine. The volume of levobupivacaine used in this study is consistent with that reported in other studies [4,7,10,11]. Adjuvants have been added to increase analgesia and reduce the total dose of LA used, minimising the risk for LA toxicity [4,13].

This study compared the effect of magnesium sulphate and fentanyl added to levobupivacaine in US-guided SCB for upper limb surgery. Magnesium sulphate, an NMDA receptor antagonist in the central and peripheral nervous systems, prolonged analgesia and reduced postoperative opioid/analgesic consumption [1,14-17]. Magnesium sulphate, an NMDA receptor antagonist, enhances analgesia by regulating calcium influx, reducing central sensitisation, and inhibiting nociceptive transmission through C fibers, thereby prolonging analgesia and decreasing postoperative analgesic requirements. It also prevents hypersensitisation by blocking NMDA receptor activation by excitatory neurotransmitters such as glutamate and aspartate [1]. Opioids are well known to have analgesic effects at the central and spinal cord levels. Fentanyl, a μ-opioid receptor agonist, prolongs analgesia and improves block characteristics through multiple mechanisms. It acts on peripheral opioid receptors, including those in dorsal roots, and may also diffuse into the epidural and subarachnoid spaces to exert central effects at the dorsal horn.

Additionally, fentanyl potentiates the action of LAs, contributing to enhanced and prolonged analgesia [18-20].

The authors have used 250 mg of Magnesium Sulphate added to Levobupivacaine. In dose-defining studies, 125 mg and 250 mg of magnesium sulphate were used. They observed prolonged duration of postoperative analgesia in a dose-dependent manner [8,21]. Authors have used lower doses, i.e., 150, 200 mg, and it delayed the block onset, and high doses either didn't alter, or block onset was delayed or insignificantly hastened the onset of block [17]. Mukherjee K et al., used 150 mg of Magnesium sulphate added to LA. They observed increased duration of sensory and motor block, and a longer time to first rescue analgesia use, and decreased total analgesic need compared with the placebo group [1]. Choi IG et al., also used Magnesium Sulphate added to 0.2% ropivacaine for upper extremity surgery, and they concluded that Magnesium Sulphate did not reduce the level of postoperative pain and opioid consumption. Probably, they used lower volumes and lower concentrations of ropivacaine, and a block was given postoperatively [22]. Gupta M in their study concluded that the addition of fentanyl to LAs injected during brachial plexus block has been shown to shorten the onset time of sensory as well as motor blockade and prolongs the duration of blockade as compared with Magnesium sulphate. They had used 50 µg of fentanyl and 150 mg of magnesium sulphate with LA. It also decreases the postoperative systemic analgesic requirements [2].

The onset of sensory block was earlier in Group F than in Group M ($p<0.0001$). The reasons for the early onset of action - First, it may alter the solution's pH, have a direct, local effect on the peripheral nerves themselves by binding to peripheral opioid receptors on sensory nerve fibers and their terminals. Second, when absorbed systemically, fentanyl can activate opioid receptors in the central nervous system. Gupta M found that the addition of Magnesium sulphate and fentanyl prolongs the onset time of sensory block as compared to LA alone. However, the difference in the onset of sensory block between the two drugs was not statistically significant [2]. Similarly to our study, other authors observed a faster onset time of sensory block in the fentanyl group than in the magnesium sulphate group [2,5,23]. Complete sensory blockade was faster in Group F compared to Group M ($p<0.001$). None of the authors has observed this parameter in their study. The duration of sensory blockade was prolonged in Group M as compared to Group F ($p<0.0001$). In contrast to the present study, Hossain ME et al., and Gupta M observed a longer duration of sensory block in the fentanyl group than in the magnesium sulphate group; this discrepancy might be due to the lower magnesium sulphate dosage used [2,23].

In the present study, there was no significant difference in haemodynamic parameters between the two groups. Various authors also found similar observations in their studies [7,17,23-25]. The duration of postoperative analgesia was prolonged in Group M as compared to Group F ($p =0.003$). Similarly, Sharma A et al., observed prolonged postoperative analgesia and fewer rescue analgesia requirements during the 24-hour postoperative period in the magnesium group compared with the placebo group [17]. In contrast to the present study, Gupta-M observed a lower VAS score in Group F from the 8th hour to the 18th hour compared to Group M, which showed a higher VAS score at the same time but a lower VAS score at the 24th hour [2].

In present study, patients in Group M required significantly fewer rescue analgesia in the first 24 hours postoperatively than patients in Group F ($p=0.011$). Gupta M did not observe a difference in the number of rescue analgesia between Groups-F and M [2]. Various authors in their studies observed that the use of rescue analgesia was maximum in the placebo group compared to the fentanyl and magnesium sulphate group [2,9].

The authors did not observe any side-effects, such as nausea, vomiting, hypotension, bradycardia, local hematoma, respiratory depression, hypoxia, pneumothorax, or nerve injury, in either group.

Limitation(s)

The limitation of the study was that blinding was not done, which could have increased the objectivity and credibility of the results.

CONCLUSION(S)

Magnesium sulphate demonstrated superior prolongation of sensory and motor blockade and enhanced postoperative analgesia with decreased 24-hour rescue analgesic consumption compared with fentanyl. However, fentanyl achieved an earlier onset and faster attainment of complete sensory blockade. The choice between these adjuvants should therefore be guided by clinical priorities, balancing rapid onset against prolonged analgesic benefit.

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