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EFFECT OF MAGNESIUM SULFATE AND DEXAMETHASONE AS ADDITIVE TO LEVOBUPIVACINE IN ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK- A COMPARATIVE STUDY

Anaesthesiology

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ABSTRACT

Background: Ultrasound-guided supraclavicular brachial plexus block is widely used for upper-limb surgery because it provides effective anaesthesia and postoperative analgesia. Addition of suitable adjuvants to levobupivacaine may improve block characteristics and prolong pain relief. **Objectives:** To compare magnesium sulfate and dexamethasone as adjuvants to levobupivacaine with respect to sensory and motor block characteristics, postoperative analgesia, rescue analgesic requirement, hemodynamic stability, pain scores, and adverse effects. **Materials and Methods:** This prospective, randomized, double-blind comparative study included 60 ASA physical status I–II patients aged 18–65 years undergoing upper-limb surgery. Patients were equally randomized into Group LD receiving 18 mL 0.5% levobupivacaine with dexamethasone 8 mg, Group LM receiving levobupivacaine with magnesium sulfate 250 mg, and Group LN receiving levobupivacaine with normal saline. Block characteristics, hemodynamic variables, postoperative VAS scores, rescue analgesia, and complications were recorded. **Results:** Sensory block onset was 7.30 ± 0.98, 10.48 ± 0.84, and 13.43 ± 0.92 minutes in Groups LD, LM, and LN, respectively, while sensory block duration was 13.03 ± 0.52, 9.09 ± 0.52, and 6.95 ± 0.59 hours ($p<0.001$). Motor block onset and duration also significantly favored Group LD ($p<0.001$). Time to first rescue analgesia was longest in Group LD (13.53 ± 0.56 hours), with the lowest 24-hour rescue requirement. VAS scores were significantly lower in Group LD at all intervals ($p<0.001$). Complication rates were comparable ($p=0.918$). **Conclusion:** Dexamethasone was superior to magnesium sulfate in accelerating block onset, prolonging sensory and motor blockade, extending postoperative analgesia, and reducing rescue analgesic requirement without increasing adverse effects.

KEYWORDS

Levobupivacaine; Dexamethasone; Magnesium sulfate; Supraclavicular brachial plexus block; Postoperative analgesia; Ultrasound guidance.

INTRODUCTION

The brachial plexus is a complex neural network responsible for sensory and motor innervation of the upper limb. Its roots, trunks, divisions and cords demonstrate clinically relevant anatomical variability, which may influence the performance and success of regional anaesthetic procedures.[1] At the supraclavicular level, the plexus is compactly arranged, allowing local anaesthetic to reach a large proportion of neural elements and making the supraclavicular approach a reliable technique for anaesthesia and postoperative analgesia in upper-limb surgery.[2]

Ultrasound guidance has strengthened the clinical utility of supraclavicular blockade by permitting direct visualization of the plexus, surrounding structures and local anaesthetic distribution. In paediatric brachiobasilic arteriovenous fistula surgery, its addition to sevoflurane anaesthesia was associated with lower postoperative pain, reduced anaesthetic consumption, longer analgesia and more stable hemodynamics.[3] Optimization of single-shot blockade nevertheless remains important. In a three-group comparison using 0.5% ropivacaine, addition of either dexmedetomidine or magnesium sulfate produced earlier sensory and motor blockade and prolonged block duration and postoperative analgesia compared with ropivacaine alone, with the greatest effect observed with dexmedetomidine.[4]

Among long-acting local anaesthetics, levobupivacaine provides a useful platform for adjuvant-based regional analgesia. Addition of 8 mg dexamethasone to 0.5% levobupivacaine has been associated with faster sensory and motor block onset, longer blockade, delayed first rescue analgesia and reduced rescue-analgesic requirement.[5] Magnesium sulfate and dexamethasone have also been directly compared as adjuvants to levobupivacaine in peripheral nerve blockade, demonstrating clinically relevant differences in postoperative analgesic efficacy.[6]

More recent brachial plexus studies have further compared these two adjuvants. With bupivacaine in ultrasound-guided infraclavicular block, dexamethasone produced more prolonged sensory and motor blockade and analgesia than magnesium sulfate.[7] Similar superiority in analgesic efficacy has been demonstrated when the agents were combined with ropivacaine for supraclavicular blockade.[8]

Dose selection may also influence the effect of dexamethasone. A randomized, controlled, triple-blind dose-finding trial using 0–4 mg perineural dexamethasone with 20 mL of 0.5% ropivacaine for interscalene block demonstrated a dose–response relationship with duration of analgesia within this dose range.[9] Contemporary supraclavicular evidence likewise demonstrates faster onset, substantially longer blockade and reduced rescue-analgesic requirement with dexamethasone compared with magnesium sulfate.[10] These findings support a direct evaluation of both adjuvants with levobupivacaine to determine their relative effects on block characteristics, postoperative analgesia, hemodynamic stability, adverse events and rescue-analgesic consumption in an Indian tertiary-care setting.

MATERIAL AND METHODS

Study Design: This was a prospective, randomized, double-blind comparative study designed to evaluate magnesium sulfate and dexamethasone as adjuvants to levobupivacaine for ultrasound-guided supraclavicular brachial plexus block.

Study Setting and Duration: The study was conducted in the Department of Anaesthesiology, BRD Medical College, Gorakhpur, over a period of one year. Patients undergoing elective upper-limb surgery were recruited from the operating theatre schedule.

Study Population: Adult patients aged 18–65 years with American Society of Anesthesiologists (ASA) physical status I or II, scheduled

for upper-limb surgery under supraclavicular brachial plexus block, constituted the study population.

Sample Size: A total of 60 patients were enrolled, with 20 participants in each group. Sample size was calculated for comparison of means at 95% confidence and 80% statistical power.

Inclusion Criteria: Patients aged 18–65 years, belonging to ASA physical status I–II, undergoing upper-limb surgery and providing written informed consent were included.

Exclusion Criteria: Patients with refusal to participate, local-site infection, ASA III–IV status, renal or hepatic disease, hemodynamic instability, BMI >35 kg/m², neuropathy of the operative limb, coagulopathy, pregnancy, or long-term steroid therapy were excluded. Randomization and Blinding: Eligible patients were allocated using a computer-generated random-number sequence with concealment by sealed opaque envelopes. Patients and the anaesthesiologist assessing study outcomes were blinded to group allocation.

Study Groups: Group LN received 18 mL of 0.5% levobupivacaine with 2 mL normal saline; Group LM received 18 mL of 0.5% levobupivacaine with 250 mg magnesium sulfate in 2 mL; and Group LD received 18 mL of 0.5% levobupivacaine with 8 mg dexame-thasone in 2 mL.

Block Technique and Data Collection: Under standard monitoring, ultrasound-guided supraclavicular block was performed using a 6–13 MHz linear transducer and a 20G, 100-mm insulated needle through an in-plane approach. Sensory and motor blockade were assessed using Hollmen's scale and Modified Bromage Scale, respectively. Hemodynamic parameters were monitored intraoperatively. Postoperative VAS scores were recorded at 2, 4, 6, 12 and 24 hours, along with time to first rescue analgesia, analgesic consumption and adverse events.

Ethical Consideration: Approval was obtained from the College Research Council and Institutional Human Ethics Committee. Written informed consent and confidentiality were ensured in accordance with the Declaration of Helsinki.

Statistical Analysis: Data were analyzed by SPSS 24.0 version. Continuous variables were summarized as mean ± SD and categorical variables as frequencies and percentages. Intergroup comparisons were performed using appropriate parametric or non-parametric tests according to data distribution, with $p<0.05$ considered statistically significant.

RESULTS

Table 1. Comparison of Heart Rate (HR) Among the Three Study Groups at Different Time Intervals

Time Point	Group LD (n=20) Mean ± SD	Group LM (n=20) Mean ± SD	Group LN (n=20) Mean ± SD	F-value	p-value
15 min	79.45 ± 6.13	79.00 ± 5.59	76.75 ± 5.57	1.256	0.292
30 min	79.65 ± 5.76	79.50 ± 5.40	77.75 ± 5.92	0.688	0.507
45 min	78.50 ± 6.99	78.55 ± 5.62	77.65 ± 5.36	0.141	0.869
60 min	78.90 ± 6.93	78.30 ± 5.94	78.10 ± 5.26	0.094	0.911

Values expressed as Mean ± Standard Deviation. One-way ANOVA applied.

There was no difference in the mean heart rate between the LD, LM and LN groups during intra-operative observation (Table 1). There were no significant intergroup differences at 15, 30, 45 or 60 min (all $p > 0.05$). The results show that heart rate profiles remained stable throughout the procedure in all three treatment groups.

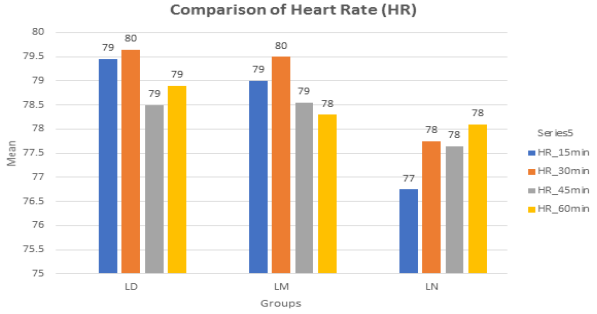

Figure 1. Comparison of Heart Rate (HR) Among the Three Study Groups at Different Time Intervals

Table 2. Comparison of Sensory Block Characteristics Among the Three Study Groups

Parameter	Group LD (n=20) Mean ± SD	Group LM (n=20) Mean ± SD	Group LN (n=20) Mean ± SD	F-value	p-value
Onset of Sensory Block (min)	7.30 ± 0.98	10.48 ± 0.84	13.43 ± 0.92	224.412	<0.001
Duration of Sensory Block (hr)	13.03 ± 0.52	9.09 ± 0.52	6.95 ± 0.59	639.439	<0.001

Values expressed as Mean ± Standard Deviation. One-way ANOVA applied.

The characteristics of sensory block showed significant difference among the three groups (Table 2). Group LD had the least time to onset of sensory block (7.30 ± 0.98 min) and the longest duration (13.03 ± 0.52 hr) followed by group LM and group LN. Both comparisons were highly statistically significant ($p<0.001$) demonstrating better sensory blockade with dexamethasone.

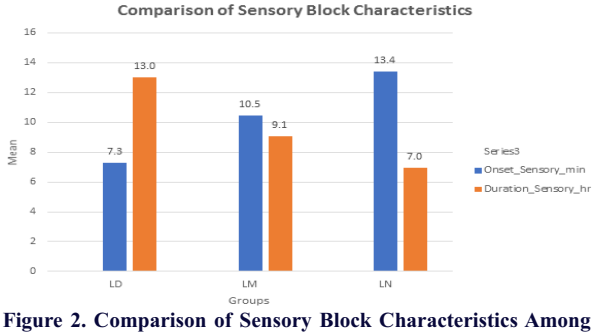

Figure 2. Comparison of Sensory Block Characteristics Among the Three Study Groups

Table 3. Comparison of Motor Block Characteristics Among the Three Study Groups

Parameter	Group LD (n=20) Mean ± SD	Group LM (n=20) Mean ± SD	Group LN (n=20) Mean ± SD	F value	p-value
Onset of Motor Block (min)	9.53 ± 0.87	12.55 ± 0.88	16.02 ± 1.13	226.854	<0.001
Duration of Motor Block (hr)	10.84 ± 0.52	7.76 ± 0.54	6.08 ± 0.65	351.741	<0.001

Values expressed as Mean ± Standard Deviation. One-way ANOVA applied.

Motor block characteristics were significantly different between the three study groups (Table 3). Group LD showed the earliest onset (9.53 ± 0.87 min) and longest duration (10.84 ± 0.52 hr) of motor block followed by Group LM and Group LN. Both parameters differed significantly across groups ($p<0.001$), favoring dexamethasone as the adjuvant.

Table 4. Comparison of Postoperative Rescue Analgesia Requirements Among the Three Study Groups

Parameter	Group LD (n=20) Mean ± SD	Group LM (n=20) Mean ± SD	Group LN (n=20) Mean ± SD	F value	p-value
Time to First Rescue Analgesia (hr)	13.53 ± 0.56	9.38 ± 0.67	7.58 ± 0.59	498.807	<0.001
Number of Rescue Analgesic Doses (24 hr)	3.65 ± 0.75	4.65 ± 0.75	5.25 ± 0.72	24.143	<0.001

Values expressed as Mean ± Standard Deviation. One-way ANOVA applied.

Table 4 shows that postoperative analgesic requirements differed significantly among the three groups. Group LD had the longest time to first rescue analgesia (13.53 ± 0.56 hr) and required the fewest rescue doses within 24 hours (3.65 ± 0.75). Both the results were significantly better than Groups LM and LN ($p<0.001$) indicating superior postoperative analgesia with dexamethasone.

Table 5. Comparison of Postoperative VAS Pain Scores Among the Three Study Groups at Different Time Intervals

Time Point	Group LD (n=20) Mean ± SD	Group LM (n=20) Mean ± SD	Group LN (n=20) Mean ± SD	F value	p-value

VAS at 2 hours	2.07 ± 0.27	3.01 ± 0.30	3.97 ± 0.32	205.695	<0.001
VAS at 4 hours	2.06 ± 0.27	2.91 ± 0.25	3.97 ± 0.27	265.321	<0.001
VAS at 6 hours	2.55 ± 0.33	3.51 ± 0.32	4.46 ± 0.33	173.538	<0.001
VAS at 12 hours	2.88 ± 0.24	3.48 ± 0.34	4.45 ± 0.35	129.761	<0.001
VAS at 24 hours	1.92 ± 0.32	2.88 ± 0.30	3.98 ± 0.28	240.986	<0.001

Values expressed as Mean ± Standard Deviation. One-way ANOVA applied.

Statistically significant differences were found between the three groups at the postoperative time points in VAS pain scores (p<0.001) (Table 5). Pain scores were lowest consistently in Group LD followed by Group LN and Group LM had the highest values. Dexamethasone provides better and prolonged postoperative analgesia as compared to magnesium sulfate and levobupivacaine alone.

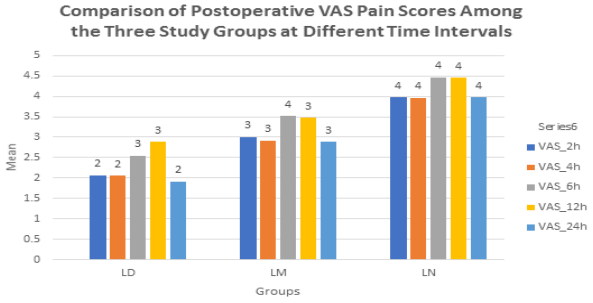

Figure 3. Comparison of Postoperative VAS Pain Scores Among the Three Study Groups at Different Time Intervals

Table 6. Distribution of Postoperative Complications Among the Three Study Groups

Complication	Group LD (n=20)	Group LM (n=20)	Group LN (n=20)	Total (N=60)	p-value
Nausea	2 (10.0%)	2 (10.0%)	1 (5.0%)	5 (8.3%)	0.918
Nausea and Vomiting	1 (5.0%)	2 (10.0%)	1 (5.0%)	4 (6.7%)	
Pain at Injection Site	1 (5.0%)	0 (0.0%)	1 (5.0%)	2 (3.3%)	
None	16 (80.0%)	16 (80.0%)	17 (85.0%)	49 (81.7%)	
Total	20 (100%)	20 (100%)	20 (100%)	60 (100%)	

Table 6 shows that postoperative complications were rare and similar across the 3 study groups. Most patients had uncomplicated course (80.0% in groups LD and LM and 85.0% in group LN). Nausea, vomiting and injection site pain were uncommon. The complication rates were not statistically different (p=0.918) demonstrating similar safety profiles in both groups.

DISCUSSION

Stable heart rate at 15 min (79.45 ± 6.13, 79.00 ± 5.59, 76.75 ± 5.57 bpm, p=0.292), 30 min (p=0.507), 45 min (p=0.869) and 60 min (p=0.911) There was no significant difference between group LD, LM and LN in heart rate. This is consistent with Tewari et al., (2025)[8] and Güneş et al., (2025)[7] who observed stable perioperative hemodynamics with dexamethasone and magnesium sulfate. Khatoon et al (2025)[10] also found hemodynamic stability, also reported transient hypotension at 30min in magnesium group. Elsawy et al. (2025)3 also reported that the supraclavicular block was associated with better hemodynamic stability No study reported the opposite pattern of HR.

Sensory block performance favored Group LD, in which onset was 7.30 ± 0.98 minutes and duration 13.03 ± 0.52 hours, compared with 10.48 ± 0.84 minutes and 9.09 ± 0.52 hours in Group LM and 13.43 ± 0.92 minutes and 6.95 ± 0.59 hours in Group LN; both comparisons were significant at p<0.001. Similarly, faster sensory onset and longer blockade was observed in the studies of Das et al., (2022)[5], Güneş et al., (2025)[7], Tewari et al., (2025)[8] and Khatoon et al., (2025)[10] with dexamethasone. Shukla et al. (2021)[4] also showed an intermediate benefit with magnesium sulfate but in that trial, dexmedetomidine was the most effective adjuvant and not dexamethasone.

The motor block features were similar with a graded pattern, Group LD showing the earliest onset (9.53 ± 0.87 minutes) and longest duration (10.84 ± 0.52 hours) followed by Group LM (12.55 ± 0.88 minutes; 7.76 ± 0.54 hours) and Group LN (16.02 ± 1.13 minutes; 6.08 ± 0.65 hours), p<0.001 for both outcomes. This is in agreement with findings of Das et al. (2022)[5], Güneş et al. (2025)[7], Tewari et al. (2025)[8] and Khatoon et al., (2025)[10]. A similar comparative finding pharmacologically, magnesium was better than control group but dexmedetomidine produced the greatest augmentation of motor-block (Shukla et al. 2021)[4].

Time to first rescue analgesia was longest in Group LD (13.53 ± 0.56 hr), followed by Group LM (9.38 ± 0.67 hr) and Group LN (7.58 ± 0.59 hr), while 24-hour rescue doses were lowest in Group LD (3.65 ± 0.75) and highest in Group LN (5.25 ± 0.72); both differences were significant (p<0.001). Similar results were obtained for dexamethasone and control 749.38±62.41 min and 431.50±46.15 min (p<0.001) by Das et al, (2022)5 Tewari et al (2025)[8] Analgesia 1211.12±111.22 Vs 498.18±64.44 min (p<0.001) Ahmed et al. (2023)6 and Khatoon et al. (2025)10 reported that dexamethasone improved the duration of analgesia and decreased the consumption of analgesia.

Postoperative VAS scores were consistently lowest in Group LD and highest in Group LN, with values at 2 hours of 2.07 ± 0.27, 3.01 ± 0.30, and 3.97 ± 0.32, respectively, and at 24 hours of 1.92 ± 0.32, 2.88 ± 0.30, and 3.98 ± 0.28; differences remained significant at every assessment (p<0.001). Güneş et al. (2025)[7] also reported that dexamethasone reduced VAS scores at 12 and 24 hour. Ahmed et al (2023)[6] and Elsawy et al (2025)[3] also showed better regional analgesia and decreased post op pain scores . However, Albrecht et al., (2019)9 did not show significant differences in secondary pain score outcomes with extended analgesia.

There were few post operative complications and they were not statistically significant. 80.0%, 80.0% and 85.0% of Group LD, Group LM and Group LN did not have any complications respectively. Nausea was seen in 10.0%, 10.0% and 5.0% respectively. The overall difference was not significant (p=0.918). Elsawy et al., (2025)3 proved the technique to be safe and feasible as well3 Khatoon et al. (2025)10 reported that the overall hemodynamic stability was transient hypotension with magnesium group at 30 min. However, Shukla et al. (2021)4 reported that the use of dexmedetomidine increased hypotension, bradycardia and sedation suggesting a specific safety difference of the adjuvants.

CONCLUSION

The results suggest that the combination of dexamethasone with 0.5% levobupivacaine for ultrasound-guided supraclavicular brachial plexus block produced the best overall block profile in comparison to magnesium sulfate and levobupivacaine alone. Group LD had the fastest onset of sensory and motor block, the longest duration of sensory and motor block and the maximum prolongation of postoperative analgesia with significantly delayed requirement of first rescue analgesia and rescue doses in 24 hours (p<0.001). Postoperative VAS scores were lowest with dexamethasone consistently at all the assessed intervals confirming superior and sustained analgesic efficacy. Magnesium sulfate improved block characteristics and postoperative pain control compared to control but less so than dexamethasone. There were no significant differences in heart rate between groups and postoperative adverse events were few and similar (p=0.918), demonstrating that both adjuvants were clinically well tolerated and did not affect perioperative safety.

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