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Original Research Article

Comparison of Bupivacaine–Magnesium Sulphate versus Ropivacaine–Magnesium Sulphate for Surgical Site Infiltration in Lumbar Spine Surgery: A Prospective Randomized Double-Blind Study

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Abstract

Background: Lumbar spine surgeries often result in significant postoperative pain, and achieving effective analgesia is essential for early mobilization and enhanced recovery. Local anesthetic wound infiltration is a simple and effective component of multimodal analgesia. This study compares the analgesic efficacy of bupivacaine–magnesium sulphate versus ropivacaine–magnesium sulphate for surgical site infiltration in lumbar spine surgery.

Methods: This prospective, randomized, double-blind study included 70 ASA I–II patients aged 25–60 years undergoing elective lumbar spine surgery. Patients were allocated to two groups (n=35 each). Group A received 70 mg bupivacaine with 500 mg magnesium sulphate diluted to 20 mL; Group B received 70 mg ropivacaine with 500 mg magnesium sulphate diluted to 20 mL. The study evaluated postoperative pain using the Visual Analog Scale (VAS) at extubation, 6, 12, and 24 hours; time to first rescue analgesia; total diclofenac consumption within 24 hours; hemodynamic parameters; and adverse effects.

Results: Demographic variables were comparable between groups. VAS scores at 6, 12, and 24 hours were significantly lower in Group B ($p < 0.05$). The time to first rescue analgesia was significantly longer in Group B (8.49 ± 4.11 h) compared with Group A (5.51 ± 3.21 h; $p = 0.0012$). Total diclofenac consumption was also significantly lower in Group B (128.57 ± 71.77 mg) than in Group A (188.57 ± 61.34 mg; $p = 0.0004$). Hemodynamic stability and adverse event profiles were similar in both groups.

Conclusion: Ropivacaine combined with magnesium sulphate provides superior postoperative analgesia compared with bupivacaine–magnesium sulphate in lumbar spine surgery. It prolongs analgesia duration, lowers pain scores, and reduces rescue analgesic requirements while maintaining a comparable safety profile. Ropivacaine–magnesium infiltration may be preferred as part of multimodal analgesia protocols in lumbar spine procedures.

Keywords: Lumbar Spine Surgery; Wound Infiltration; Ropivacaine; Bupivacaine; Magnesium Sulphate; Postoperative Analgesia.

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Introduction

Lumbar spine surgeries, including decompression and laminectomy, are associated with significant postoperative pain due to tissue manipulation, nerve irritation, and inflammatory responses. Inadequate analgesia in the early postoperative period may delay mobilization, prolong hospitalization, and negatively impact functional recovery [1]. The emphasis on enhanced recovery pathways has further increased the need for effective multimodal postoperative pain management strategies [2]. Local anesthetic wound infiltration has emerged as a simple, safe, and clinically effective analgesic modality that directly targets nociceptive pathways at the surgical site. It has been used across multiple surgical disciplines and shown to reduce opioid consumption, improve pain scores, and support early mobilization [3,4]. Bupivacaine and ropivacaine are the most

commonly used long-acting amide local anesthetics for this purpose. While both provide effective sensory blockade, differences in their physicochemical profiles—particularly the lower cardiotoxic potential of ropivacaine—make their comparative performance clinically relevant in postoperative analgesia [5].

To further enhance the duration and quality of analgesia, magnesium sulphate has been explored as an adjuvant due to its NMDA receptor antagonism and calcium channel-blocking properties.

When combined with local anesthetics, magnesium has demonstrated reduced opioid requirements and improved postoperative pain control in various surgical scenarios, including prostatectomy, cesarean section, and abdominal procedures [6–8]. However, limited evidence exists comparing different local anesthetic–magnesium combinations specifically in lumbar spine surgery.

Methods

This prospective, randomized, double-blind comparative study was conducted in the Neurosurgery Operating Theatre, Department of Anaesthesiology, SMS Medical College, and Jaipur.

Study Population: Seventy adult patients aged 25–60 years, ASA I–II, undergoing elective lumbar spine surgery under general anaesthesia, were enrolled.

Exclusion criteria included seizure disorders, severe systemic disease, renal dysfunction, psychiatric illness, allergy to study drugs, BMI > 35 kg/m², coagulation disorders, and chronic analgesic use.

Randomization and Group Allocation: Patients were randomly assigned into two equal groups (n = 35 each) using a sealed-envelope technique. Both patients and outcome assessors were blinded.

- **Group A:** 70 mg bupivacaine (14 mL) + 500 mg magnesium sulphate (1 mL), diluted to 20 mL.
- **Group B:** 70 mg ropivacaine (14 mL) + 500 mg magnesium sulphate (1 mL), diluted to 20 mL.

The infiltration solution was prepared by an anesthesiologist not involved in postoperative assessment.

Anesthesia Technique: Standard monitoring was applied. Patients received IV glycopyrrolate, metoclopramide, midazolam, and fentanyl. Induction was performed using propofol and succinylcholine, followed by intubation. Anaesthesia was maintained with sevoflurane, nitrous oxide–oxygen mixture, and atracurium infusion.

At wound closure, the assigned infiltration mixture was administered into paravertebral muscles and subcutaneous layers by the surgeon. After induction and endotracheal intubation, patients were carefully positioned in the prone position with adequate padding at pressure points to avoid nerve and pressure-related injuries. Hemodynamic parameters were reassessed after positioning

Outcome Measures

Primary Outcomes:

- VAS at extubation, 6, 12, and 24 hours
- Time to first rescue analgesia
- Total diclofenac consumption in 24 hours

Secondary Outcomes:

- Hemodynamic parameters: HR, SBP, DBP, MAP, SpO_2
- Adverse effects: nausea, vomiting, sedation, hypotension, respiratory depression, allergic reactions

Pain and Rescue Analgesia Protocol: VAS ≥ 4 triggered administration of IV diclofenac 75 mg. Total doses over 24 hours were recorded. Time from extubation to first analgesic dose was noted.

Statistical Analysis: Data were analyzed using SPSS 29. Continuous variables were expressed as mean ± SD and compared using Student's t-test. Categorical variables were analyzed using Chi-square test. A P-value <0.05 was considered statistically significant.

Results

Table 1: Demographic Profile of Patients

Variable	Group A (n=35)	Group B (n=35)	P value
Age (years)	41.6 ± 11.63	43.66 ± 8.85	0.408
Gender (M/F)	19/16	15/20	0.473
BMI (kg/m²)	23.71 ± 2.88	24.04 ± 3.44	0.644
ASA I/II	16/19	21/14	0.338

Table 2: Postoperative VAS Scores

Time	Group A	Group B	P value
Extubation	3.77 ± 1.03	3.71 ± 0.96	0.811
6 hours	3.74 ± 0.98	2.86 ± 0.81	<0.001
12 hours	4.11 ± 1.02	3.11 ± 1.08	<0.001
24 hours	4.09 ± 1.20	3.29 ± 1.10	0.005

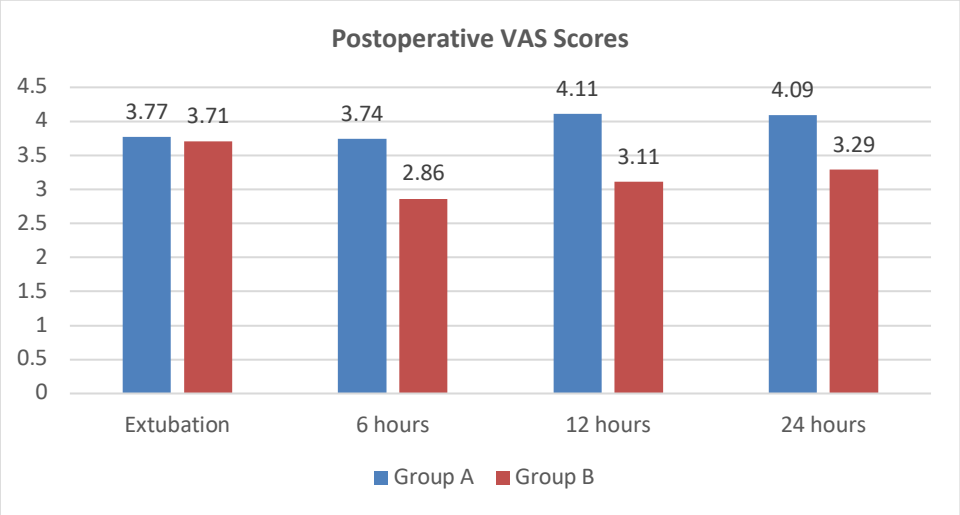

Figure 1: Postoperative VAS Scores

Table 3: Postoperative Analgesic Requirement

Parameter	Group A (n = 35)	Group B (n = 35)	P value
Time to first rescue analgesia (hours)	5.51 ± 3.21	8.49 ± 4.11	0.0012
Total diclofenac consumption (mg) in 24 h	188.57 ± 61.34	128.57 ± 71.77	0.0004
Patients requiring 1 dose, n (%)	3 (8.57%)	19 (54.29%)	<0.001
Patients requiring 2 doses, n (%)	15 (42.86%)	10 (28.57%)	
Patients requiring 3 doses, n (%)	13 (37.14%)	3 (8.57%)	

Table 4: Adverse Events

Event	Group A	Group B	P value
Sedation	3	2	0.642
Hypotension	2	1	0.555
Nausea/Vomiting	1	1	1.0

Discussion

The present study compared the postoperative analgesic efficacy of bupivacaine–magnesium sulphate and ropivacaine–magnesium sulphate used for surgical site infiltration in patients undergoing lumbar spine surgery. The results demonstrated that the ropivacaine–magnesium combination provided significantly better postoperative pain control, as reflected by lower VAS scores at 6, 12, and 24 hours, a longer duration before the first requirement of rescue analgesia, and reduced total diclofenac consumption within the first 24 postoperative hours. These findings support the role of wound infiltration as an effective component of multimodal analgesia in lumbar spine surgery, as reported in earlier studies [1,3,4]. The superior analgesia observed with ropivacaine–magnesium sulphate is consistent with previous literature evaluating magnesium as an adjuvant to local anesthetics. Donadi et al. reported prolonged postoperative analgesia with the addition of magnesium to bupivacaine infiltration in lumbar laminectomy patients [9], while Kundra et al. demonstrated improved pain control when magnesium was added to ropivacaine in postoperative analgesia [10].

The analgesic effect of magnesium is primarily attributed to its N-methyl-D-aspartate (NMDA) receptor antagonism and calcium channel blockade, which reduce central sensitization and nociceptive transmission [11,12]. In addition, ropivacaine has been shown to provide effective sensory blockade with a favorable safety profile, which may contribute to improved postoperative outcomes [5]. Although Hazarika et al. observed better analgesia with bupivacaine–magnesium compared with ropivacaine–magnesium infiltration [13], differences in local anesthetic concentration and

dosing protocols may explain the variation in results. More recent studies by Sane et al. and Demiroglu et al. support the findings of the present study, demonstrating reduced analgesic requirements and improved pain scores with local infiltration of ropivacaine combined with magnesium sulphate in lumbar spine procedures [12,14]. In the present study, both groups exhibited comparable hemodynamic stability and adverse event profiles, indicating that the enhanced analgesic efficacy of ropivacaine–magnesium sulphate was achieved without compromising patient safety.

Conclusion

Ropivacaine combined with magnesium sulphate provides superior postoperative analgesia compared with bupivacaine–magnesium infiltration in lumbar spine surgery. It results in lower pain scores, prolonged analgesia duration, and reduced rescue analgesic requirements, with comparable safety. This combination may be preferred as part of multimodal analgesia protocol

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