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Comparing the Effects of Magnesium Sulphate or Dexamethasone for Post Operative Analgesia in Adult Patients for Laparoscopic Cholecystectomy

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ABSTRACT

Background: Postoperative pain after laparoscopic cholecystectomy, though less severe than open procedures, remains clinically significant. This study compared the analgesic efficacy and hemodynamic effects of intravenous magnesium sulphate and dexamethasone.

Methods: This prospective comparative study included 40 adult patients (ASA I–II) undergoing elective laparoscopic cholecystectomy under general anaesthesia. Patients were randomly assigned into two groups (n=20 each): Group M received magnesium sulphate 1 g IV, and Group D received dexamethasone 6 mg IV before induction. Postoperative pain was assessed using the Numeric Rating Scale (NRS) at 10 minutes, 2 hours, 6 hours, 12 hours, 18 hours, and 24 hours. Hemodynamic parameters and rescue analgesic requirements were recorded. Statistical significance was considered at $p<0.05$.

Results: Demographic characteristics were comparable between the groups ($p>0.05$). Group M showed significantly better attenuation of hemodynamic responses, with lower heart rate at intubation (88.5±9.2 vs 98.4±10.1 bpm, $p=0.001$) and lower systolic blood pressure (132.7±11.3 vs 145.8±12.1 mmHg, $p=0.0008$). NRS scores decreased progressively in both groups. Early postoperative pain scores were lower in Group M but not statistically significant ($p>0.05$). At 24 hours, Group D demonstrated significantly lower NRS scores (0.70±0.57 vs 1.05±0.51, $p=0.013$). Time to first rescue analgesia was longer in Group M (5.20±1.40 vs 4.10±1.25 hours, $p=0.018$). Rescue analgesia requirement and total doses were comparable between groups ($p>0.05$).

Conclusion: Magnesium sulphate provides superior intraoperative hemodynamic stability and prolongs early analgesia, whereas dexamethasone offers better late postoperative pain relief. Both are effective components of multimodal analgesia.

Key-words: Magnesium sulphate, Dexamethasone, Laparoscopic cholecystectomy, Postoperative pain, NRS score, Hemodynamic

INTRODUCTION

Laparoscopic cholecystectomy is the gold standard surgical procedure for the management of symptomatic gallstone disease due to its well-established advantages over open surgery, including smaller incisions, reduced postoperative pain, shorter hospital stays, faster recovery, and decreased wound-related complications. [1] Despite these benefits, postoperative pain remains a significant clinical concern, particularly within the first 24 hours. [2]

Postoperative pain following laparoscopic cholecystectomy is multifactorial in origin, comprising somatic pain from trocar insertion sites, visceral pain due to peritoneal stretching and surgical manipulation, and referred shoulder pain resulting from diaphragmatic irritation caused by residual pneumoperitoneum. Although less severe than in open procedures, this pain

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can still be moderate in intensity and warrants effective management. [3]

Optimal postoperative analgesia is essential not only for patient comfort but also for facilitating early ambulation, reducing opioid consumption, minimising opioid-related adverse effects, and enhancing recovery outcomes. Multimodal analgesia, which targets different nociceptive pathways, has emerged as the preferred strategy in laparoscopic surgeries. [4,5]

Multimodal analgesia is currently considered the cornerstone of postoperative pain management in laparoscopic cholecystectomy, as it provides superior analgesia while minimising opioid consumption and associated adverse effects. By combining systemic and regional techniques, this approach targets multiple nociceptive pathways and contributes to enhanced recovery and improved patient outcomes. [4,5]

Magnesium sulphate has emerged as an effective adjunct in perioperative analgesia due to its ability to modulate calcium influx and inhibit central sensitisation. Its antagonistic action on N-methyl-D-aspartate (NMDA) receptors plays a key role in reducing nociceptive transmission. Clinical evidence suggests that perioperative administration of magnesium sulphate is associated with decreased postoperative pain intensity and reduced opioid requirements, highlighting its analgesic and anaesthetic-sparing properties. [6,7]

Dexamethasone, a long-acting glucocorticoid, is widely utilised in the perioperative setting for its potent anti-inflammatory and antiemetic effects. Inhibiting the release of inflammatory mediators, it contributes to the attenuation of postoperative pain and the enhancement of patient comfort. Additionally, its antiemetic properties further improve recovery quality following laparoscopic cholecystectomy. [8-10]

This study is designed to assess and compare the analgesic effectiveness of intravenous magnesium sulphate and dexamethasone in patients undergoing laparoscopic cholecystectomy, with a specific focus on postoperative pain intensity, need for rescue analgesia, and overall recovery profile.

MATERIALS AND METHODS

Study Design, Setting and Duration- This comparative study was conducted in the Department of Anaesthesiology at Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru, Karnataka, over a period of 4 months. The study population comprised inpatients undergoing elective laparoscopic cholecystectomy under general anaesthesia.

Source of Data- Data were collected from adult patients admitted to Sapthagiri Hospital for elective laparoscopic cholecystectomy. A total of 40 patients who fulfilled the eligibility criteria and provided informed consent were included and followed up for 24 hours postoperatively.

Sample Size and Randomization- A total of 40 patients were enrolled after preoperative assessment and were randomly allocated into two groups of 20 each using computer-generated randomization.

Inclusion Criteria- Patients aged between 18 and 60 years, belonging to American Society of Anaesthesiologists (ASA) grade I and II, with a body mass index (BMI) between 18–28 kg/m², and willing to undergo elective laparoscopic cholecystectomy under general anaesthesia were included.

Exclusion Criteria- Patients on preoperative sedatives or hypnotics, those with psychiatric illness or alcohol abuse, known allergy to study drugs, pregnant or lactating women, and surgeries lasting more than 3 hours were excluded from the study.

Methodology- Patients were shifted to the operating room after confirming adequate fasting status. An intravenous cannula was secured, and standard monitoring, including non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and electrocardiogram (ECG), was instituted. Baseline demographic data, vital parameters, and clinical findings were recorded. Premedication was administered with intravenous glycopyrrolate (0.001 mg/kg) and midazolam (0.02 mg/kg). Preoxygenation with 100% oxygen was given for 3 minutes.

Patients were randomly assigned into two groups: Group D received intravenous dexamethasone 6 mg, and Group M received intravenous magnesium sulphate 1 g, administered 5 minutes before induction.

Anaesthesia was induced using intravenous propofol (1.5–2 mg/kg) and fentanyl (1.5–2 µg/kg). Neuromuscular blockade was achieved with vecuronium (0.1 mg/kg), followed by endotracheal intubation.

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Adequate ventilation was ensured, and additional doses of muscle relaxant were given as required.

Hemodynamic parameters were recorded at baseline, after study drug administration, post-induction, after intubation, at surgical incision, and at 15-minute intervals until completion of surgery. At the end of surgery, neuromuscular blockade was reversed using neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg). Extubation was performed after meeting standard criteria. Postoperative pain assessment was done using the Numeric Rating Scale (NRS) at 10 minutes, 2 hours, 6 hours, 12 hours, 18 hours, and 24 hours after extubation. Rescue analgesia was provided with intravenous paracetamol 1 g at a minimum interval of 8 hours. All intraoperative and postoperative data were recorded in the case record proforma.

Statistical Analysis- Data collected were entered into Microsoft Excel and analyzed using SPSS version 20. Baseline demographic and clinical characteristics were analyzed using descriptive statistics, including mean, median, standard deviation, and interquartile range for continuous variables, and frequencies with percentages for categorical variables. Based on the distribution of data, appropriate parametric and non-parametric tests such as Student's t-test, ANOVA, Z-test, and chi-square test were applied. A p-value of <0.05 was considered statistically significant.

Ethical Considerations- The study was conducted after obtaining approval from the Institutional Ethics Committee (SIMS & RC/EC-13/PG-06/2025-26) and was registered with the Clinical Trials Registry of India (CTRI/2025/08/093293). Written informed consent was obtained from all participants before enrolment.

RESULTS

Baseline demographic and clinical characteristics were comparable between Group M and Group D. Mean age was 48.70±11.02 years in Group M and 45.60±10.87 years in Group D (p=0.37). Mean BMI was 26.10±2.10 kg/m² in Group M versus 25.20±2.30 kg/m² in Group D (p=0.20). ASA physical status distribution was also similar, with no significant difference between groups (p=0.74). These findings indicate that both groups were well-matched at baseline, allowing for a reliable comparison of postoperative outcomes (Table 1).

Table 1: Demographic parameters of study participants (N=40)

Parameters	Group M (n=20) (Mean±SD)	Group D (n=20) (Mean±SD)	p-value
AGE	48.70±11.02	45.60 ±10.87	0.37
BMI (kg/m$^{2)}$	26.10±2.10	25.20±2.30	0.20
ASA (1/2)	12/8	11/9	0.74

Preoperative heart rate was comparable between Group M (82.4±8.6 bpm) and Group D (81.7±7.9 bpm), with no statistically significant difference (p=0.78). Similarly, after administration of the study drug and following induction, both groups remained comparable (p>0.05), indicating adequate baseline homogeneity. Following laryngoscopy and intubation, there was a significant rise in heart rate in both groups; however, the increase was markedly higher in Group D (98.4±10.1 bpm) compared to Group M (88.5±9.2 bpm), which was statistically highly significant (p=0.001).

At the time of surgical incision (0 min) and during the intraoperative period (15 to 105 minutes), heart rate remained consistently lower in Group M compared to Group D. This difference was statistically significant at all measured intervals (p-values ranging from 0.001 to 0.005). At post-extubation, heart rate again increased in both groups due to extubation stress response, but the rise was significantly attenuated in Group M (78.6±7.2 bpm) compared to Group D (88.9±8.4 bpm), with p=0.001 (Table 2).

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Table 2: Comparison of heart rate (hr) between Group M and Group D

Time interval	Group M	Group D	p-value
Pre operative	82.4±8.6	81.7±7.9	0.78
After bolus study drug administration	78.2±7.5	80.9±7.8	0.21
After induction	75.6±6.9	78.8±7.1	0.12
After intubation	88.5±9.2	98.4±10.1	0.001
At incision (0 min)	84.1±8.7	92.3±9.5	0.003
15 min	80.7±7.9	89.6±8.8	0.002
30 min	78.9±7.4	87.5±8.2	0.001
45 min	77.3±7.2	85.9±7.8	0.001
60 min	76.5±6.8	84.6±7.6	0.002
75 min	75.9±6.5	83.7±7.4	0.003
90 MIN	75.2±6.3	82.8±7.2	0.004
105 MIN	74.8±6.1	82.1±7.0	0.005
Post Extubation	78.6±7.2	88.9±8.4	0.001

Preoperative systolic blood pressure was comparable between Group M (128.5±10.2 mmHg) and Group D (127.8±9.8 mmHg), with no statistically significant difference (p=0.81). Similarly, SBP measured after administration of the study drug and following induction showed no significant intergroup difference (p=0.29 and p=0.10, respectively). Following laryngoscopy and intubation, SBP increased in both groups; however, the rise was significantly greater in Group D (145.8±12.1 mmHg) compared to Group M (132.7±11.3 mmHg), which was statistically highly significant (p=0.0008).

At the time of surgical incision (0 min) and throughout the intraoperative period (15–105 minutes), SBP remained consistently lower in Group M compared to Group D. This difference was statistically significant at all measured time intervals (p<0.01). At post-extubation, SBP again increased in both groups, reflecting the extubation stress response. However, Group M demonstrated significantly better attenuation (126.3±9.6 mmHg) compared to Group D (138.7±10.8 mmHg), with a statistically significant difference (p=0.001) (Table 3).

Table 3: Comparison of systolic blood pressure (SBP) between Group M and Group D

Time Interval	Group M	Group D	p-value
Pre operative	128.5±10.2	127.8±9.8	0.81
After bolus study drug administration	124.2±9.5	126.9±9.2	0.29
After induction	118.6±8.7	122.4±8.9	0.10
After intubation	132.7±11.3	145.8±12.1	0.0008
At incision (0 min)	130.1±10.9	140.6±11.5	0.002
15 min	126.4±9.8	137.2±10.8	0.001
30 min	124.9±9.2	135.5±10.3	0.001
45 min	123.6±8.9	134.2±9.7	0.001
60 min	122.8±8.5	133.1±9.4	0.002
75 min	122.1±8.2	132.4±9.1	0.003
90 min	121.6±8.0	131.7±8.9	0.004
105 MIN	121.0±7.8	131.0±8.7	0.005
Post Extubation	126.3±9.6	138.7±10.8	0.001

Preoperative diastolic blood pressure was comparable between Group M (78.6±6.4 mmHg) and Group D (77.9±6.2 mmHg), with no statistically significant difference (p=0.70). Similarly, DBP values recorded after

administration of the study drug and following induction were comparable between the two groups (p=0.25 and p=0.09, respectively). Following laryngoscopy and intubation, DBP increased in both groups; however, the rise was significantly greater in Group D (90.6±7.8 mmHg) compared to Group M (82.4±7.1 mmHg), which was statistically highly significant (p=0.001).

At the time of surgical incision (0 min) and throughout the intraoperative period (15–105 minutes), DBP remained consistently lower in Group M compared to Group D. The intergroup difference was statistically significant at all measured time points (p<0.01). At post-extubation, DBP increased in both groups due to extubation response; however, Group M demonstrated significantly better attenuation (78.1±6.1 mmHg) compared to Group D (86.5±6.9 mmHg), with a statistically significant difference (p=0.001) (Table 4).

Table 4: Comparison of diastolic blood pressure (DBP) between Group M and Group D

Time interval	Group M	Group D	p-value
Pre operative	78.6±6.4	77.9±6.2	0.70
After bolus study drug administration	75.3±5.8	77.2±6.0	0.25
After induction	72.1±5.5	74.8±5.9	0.09
After intubation	82.4±7.1	90.6±7.8	0.001
At incision (0 min)	80.2±6.8	87.9±7.4	0.002
15 min	78.5±6.5	86.2±7.1	0.001
30 min	77.3±6.2	84.9±6.9	0.001
45 min	76.4±6.0	83.7±6.7	0.001
60 min	75.8±5.8	82.9±6.5	0.002
75 min	75.2±5.6	82.1±6.3	0.003
90 min	74.7±5.4	81.5±6.1	0.004
105 min	74.2±5.3	80.9±6.0	0.005
Post Extubation	78.1±6.1	86.5±6.9	0.001

Postoperative pain was assessed using the Numerical Rating Scale (NRS) at predefined intervals (10 minutes, 2, 6, 12, 18, and 24 hours) in both the magnesium sulphate (Group M) and dexamethasone (Group D) groups. The analysis demonstrated a progressive decline in NRS scores over 24 hours in both groups, indicating effective postoperative analgesia with both study drugs.

At 10 minutes, mean NRS scores were higher in Group D compared to Group M; however, the difference was not statistically significant (p=0.08). Similarly, at 2 hours (p=0.34) and 6 hours (p=0.16), although Group M showed marginally lower pain scores, the differences did not reach statistical significance. At 12 hours (p=0.57) and 18 hours (p=0.16), NRS scores were comparable between the two groups, with no statistically significant difference observed. At 24 hours, a statistically significant difference was noted between the groups, with Group D (dexamethasone) demonstrating lower NRS scores compared to Group M (p=0.01), suggesting superior late postoperative analgesic efficacy (Table 5).

Table 5: Comparison of post-extubation NRS scores between Group M and Group D

Time Interval	Mean NRS Group M	Mean NRS Group D	p-value
10 min	6.45±0.99	6.95±0.82	0.08
2 hrs	5.05±0.60	5.30±0.57	0.34
6 hrs	4.25±0.91	4.90±0.96	0.16
12 hrs	3.05±0.60	2.95±0.51	0.57
18 hrs	2.00±0.79	1.80±0.41	0.16
24 hrs	1.05±0.51	0.70±0.57	0.01

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Rescue analgesia requirement in the first 24 hours postoperatively was compared between Group D (dexamethasone) and Group M (magnesium sulphate). The proportion of patients requiring rescue analgesia was higher in Group D (60%) compared to Group M (40%); however, this difference was not statistically significant (p=0.20), indicating comparable overall analgesic adequacy between the two groups.

The mean total number of rescue analgesic doses administered was also higher in Group D (1.80±0.77) compared to Group M (1.30±0.65). This difference approached but did not reach statistical significance (p=0.07), suggesting a trend toward increased analgesic requirement in the dexamethasone group. In contrast, the time to first rescue analgesia was significantly prolonged in Group M (5.20±1.40 hours) compared to Group D (4.10±1.25 hours), and this difference was statistically significant (p=0.02). This finding indicates that magnesium sulphate provides a longer initial pain-free period following surgery (Table 6).

Table 6: Comparison of rescue analgesia requirement in first 24 hours in group M and Group D

Parameter	Group M	Group D	p-value
Number of patients required rescue analgesia (n, %)	8 (40%)	12 (60%)	0.20
Total number of rescue doses (mean±SD)	1.30±0.65	1.80±0.77	0.07
Time to first rescue analgesia (hours)	5.20±1.40	4.10±1.25	0.02

DISCUSSION

The present study was conducted to compare the analgesic efficacy and hemodynamic effects of intravenous magnesium sulphate and dexamethasone in patients undergoing laparoscopic cholecystectomy. The findings highlight important differences in their roles in perioperative analgesia and stress response attenuation.

In the present study, baseline characteristics were similar between Group M and Group D. The mean age was 48.70±11.02 years in Group M and 45.60±10.87 years in Group D (p=0.37), while the mean BMI was 26.10±2.10 kg/m² and 25.20±2.30 kg/m², respectively (p=0.20). The distribution of ASA physical status was also comparable (p=0.74). The lack of statistically significant differences confirms proper group matching, reduces confounding factors, and supports the idea that differences in postoperative outcomes are due to the interventions.

The present study demonstrates that magnesium sulphate provides superior attenuation of the hemodynamic response to laryngoscopy, intubation, and surgical stimuli compared to dexamethasone.

Following intubation, heart rate was significantly lower in the magnesium group (88.5±9.2 bpm) compared to the dexamethasone group (98.4±10.1 bpm, p=0.001). Similarly, systolic and diastolic blood pressures were significantly lower in the magnesium group throughout the intraoperative period (p<0.01).

These findings are consistent with the observations of Prys-Roberts *et al.* [11], who demonstrated that laryngoscopy and intubation induce a marked sympathetic response. Magnesium sulphate attenuates this response by inhibiting catecholamine release and blocking calcium influx into adrenergic nerve terminals.

Koinig *et al.* [12] and Telci *et al.* [13] further demonstrated that magnesium reduces intraoperative anesthetic requirements and stabilizes hemodynamic parameters through NMDA receptor antagonism. Recent evidence by Hung *et al.* [14] and Wu *et al.* [15] has reinforced these findings, confirming that magnesium improves intraoperative stability and reduces stress responses.

In contrast, dexamethasone lacks direct sympatholytic action, explaining the relatively higher heart rate and blood pressure observed in this group.

Both groups demonstrated a progressive decline in NRS scores over 24 hours, indicating effective analgesia. In the early postoperative period (10 minutes to 6 hours), the magnesium group showed lower pain scores compared to the dexamethasone group, although the differences were not statistically significant (p>0.05). This suggests comparable early analgesic efficacy. At 24 hours, dexamethasone demonstrated significantly lower NRS scores (0.70±0.57 vs 1.05±0.51, p=0.013), indicating superior late postoperative analgesia.

This finding is supported by Bisgaard *et al.* [16], who reported improved postoperative pain outcomes with

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dexamethasone in laparoscopic cholecystectomy. Similarly, Waldron *et al.* [17] demonstrated in a meta-analysis that dexamethasone reduces postoperative pain and opioid consumption, particularly in the late postoperative period.

On the other hand, magnesium primarily acts by blocking NMDA receptors and preventing central sensitization, making it more effective in early postoperative pain control. Chen *et al.* [18] and Sousa *et al.* [19] reported that magnesium significantly reduces pain scores in the early postoperative period but has a limited effect at 24 hours, which aligns with the findings of the present study.

In the present study, although a higher proportion of patients in the dexamethasone group required rescue analgesia (60% vs 40%), the difference was not statistically significant (p=0.20). Similarly, the total number of rescue doses was higher in the dexamethasone group, but the difference did not reach statistical significance (p=0.06).

However, the time to first rescue analgesia was significantly prolonged in the magnesium group (5.20±1.40 hours vs 4.10±1.25 hours, p=0.02), indicating better early analgesic duration.

These findings are consistent with those of Koinig *et al.* [12] and demonstrate a delayed requirement for rescue analgesia with magnesium sulphate. Wu *et al.* [15] also confirmed that magnesium reduces central sensitization and prolongs analgesic effects.

LIMITATIONS

This study has several limitations. The small sample size reduces statistical power and limits generalizability. Baseline demographic differences between groups may have influenced outcomes. The study was conducted at a single centre with a short follow-up period of 24 hours, which prevents assessment of longer-term results. Additionally, opioid consumption was not measured in detail.

CONCLUSIONS

This study demonstrates that both intravenous magnesium sulphate and dexamethasone are effective components of multimodal analgesia in patients undergoing laparoscopic cholecystectomy. Magnesium sulphate was associated with superior attenuation of intraoperative hemodynamic responses to laryngoscopy, intubation, and surgical stimuli, along with a longer duration before the first requirement of rescue analgesia, indicating better early postoperative analgesic effect. In contrast, dexamethasone showed comparatively improved pain control at 24 hours, suggesting greater efficacy in the late postoperative period. Although the overall requirement for rescue analgesia and total analgesic consumption were comparable between the two groups, each drug demonstrated distinct advantages at different phases of recovery. These findings support the complementary roles of magnesium sulphate and dexamethasone in perioperative pain management. Their use as part of a balanced multimodal analgesic strategy can enhance patient comfort, improve hemodynamic stability, and contribute to better postoperative recovery outcomes.

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