

Research Article**EFFECTIVENESS OF INTRAVENOUS MAGNESIUM SULFATE IN ATTENUATING HEMODYNAMIC CHANGES DURING LAPAROSCOPIC SURGERY: A RANDOMIZED DOUBLE-BLIND CLINICAL TRIAL****Dr. Shruti Sharma¹, Dr. Jyotirmayee Patel^{2*}, Dr Kashish Ahuja³**¹Department of Anaesthesiology, Bombay Hospital, Indore, Madhya Pradesh, India^{2*}Department of Anaesthesiology, Bombay Hospital, Indore, Madhya Pradesh, India³senior Consultant and HOD, Department of Anaesthesiology, Bombay Hospital, Indore, Madhya Pradesh, India**Corresponding author: Dr Jyotirmayee Patel, Department of Anaesthesiology, Bombay Hospital Indore, M.P****Email Id: jyotirmayee Patelcims15@gmail.com****Received date: 20-09-2026, Date of Acceptance: 25-09-2026, Date of Publication: 25-09-2026.****Abstract**

Background: Carbon dioxide pneumoperitoneum during laparoscopic surgery produces sympathetic and cardiovascular responses that may complicate intraoperative hemodynamic management. Magnesium sulfate has sympatholytic, vasodilatory and analgesic properties and may attenuate these responses. This study evaluated intravenous magnesium sulfate compared with normal saline in patients undergoing elective laparoscopic surgery.

Methods: This randomized, double-blind clinical trial was conducted in the Department of Anaesthesiology, Bombay Hospital, Indore, from March 2023 to September 2024. Seventy adults aged 18–60 years with ASA physical status I or II undergoing elective laparoscopic surgery were randomized equally to receive intravenous magnesium sulfate 30 mg/kg in 100 mL normal saline or 100 mL 0.9% saline, administered as a bolus over 5 minutes. Heart rate (HR), non-invasive blood pressure and oxygen saturation were monitored. Hemodynamic variables were recorded at baseline, induction, and 5, 10, 15, 20 and 30 minutes. Ramsay Sedation Score and postoperative visual analogue pain score were assessed. Continuous variables were compared

using the unpaired t-test and categorical variables using Pearson's chi-square test; $p < 0.05$ was considered statistically significant.

Results: Baseline characteristics were comparable. Mean age was 41.26 ± 8.67 years in the magnesium group and 41.74 ± 8.01 years in the saline group ($p = 0.808$); mean weight was 70.94 ± 7.05 kg and 71.77 ± 7.06 kg, respectively ($p = 0.625$). HR was significantly lower with magnesium sulfate at 15 minutes (79.69 ± 9.26 vs 84.74 ± 11.17 bpm, $p = 0.043$), 20 minutes (78.54 ± 9.87 vs 84.77 ± 11.48 bpm, $p = 0.018$), and 30 minutes (78.43 ± 8.98 vs 85.57 ± 10.43 bpm, $p = 0.003$). SBP was significantly lower at 15 minutes (115.17 ± 11.18 vs 127.00 ± 17.97 mmHg, $p = 0.002$), 20 minutes (114.31 ± 9.93 vs 128.43 ± 17.50 mmHg, $p = 0.001$), and 30 minutes (116.49 ± 9.54 vs 128.91 ± 15.61 mmHg, $p = 0.001$). MAP was significantly lower at 15 minutes (83.89 ± 20.74 vs 93.74 ± 13.92 mmHg, $p = 0.023$), 20 minutes (88.57 ± 8.72 vs 94.63 ± 13.33 mmHg, $p = 0.028$), and 30 minutes (88.91 ± 8.43 vs 94.91 ± 12.22 mmHg, $p = 0.020$). DBP did not differ significantly at any measured time point. Mean postoperative pain score was lower with magnesium sulfate (1.31 ± 0.47 vs 2.63 ± 0.94 , $p = 0.001$), while Ramsay Sedation Score was similar (1.97 ± 0.51

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vs 1.94 ± 0.64 , $p=0.837$). No procedure-related or drug-related adverse events were reported.

Conclusion: In this selected population of adults undergoing elective laparoscopic surgery, intravenous magnesium sulfate 30 mg/kg was associated with lower HR, SBP and MAP during the later period of pneumoperitoneum and with lower postoperative pain scores, without a difference in Ramsay sedation score or reported adverse events. Larger trials with broader patient populations and longer hemodynamic and postoperative follow-up are warranted.

Keywords: magnesium sulfate; pneumoperitoneum; laparoscopic surgery; hemodynamic response; postoperative pain; randomized clinical trial.

INTRODUCTION

Laparoscopic surgery has become an important component of modern surgical practice because of its minimally invasive nature and its association with reduced postoperative pain and faster recovery. Creation of carbon dioxide pneumoperitoneum, however, produces important physiologic changes. Increased intra-abdominal pressure and neurohumoral activation can alter systemic vascular resistance, arterial pressure and heart rate, creating a challenge for maintaining stable cardiovascular conditions during anesthesia.

Magnesium sulfate is an established pharmacologic agent with effects that include attenuation of catecholamine release, vasodilation and modulation of neuromuscular and nociceptive transmission. These properties have prompted investigation of magnesium sulfate as an adjunct for blunting the cardiovascular response to pneumoperitoneum. Previous randomized studies and systematic reviews cited in the dissertation have generally reported reductions in blood pressure and, in some studies, heart rate following intravenous

magnesium administration, although findings have not been completely uniform.

The present study was undertaken to evaluate the effectiveness of intravenous magnesium sulfate in attenuating hemodynamic changes induced by pneumoperitoneum in patients undergoing elective laparoscopic surgery, and to assess its effect on sedation, postoperative pain and adverse events.

MATERIALS AND METHODS

Study design and setting

This randomized, double-blind clinical trial was conducted in the Department of Anaesthesiology, Bombay Hospital, Indore, Madhya Pradesh, India, over 18 months from March 2023 to September 2024. The study protocol was reviewed and approved by the Institutional Ethics Committee, and written informed consent was obtained before enrollment. Patient confidentiality was maintained.

Participants

Patients aged 18–60 years, of either sex, with ASA physical status I or II and scheduled for elective laparoscopic surgery were eligible. Exclusion criteria included known magnesium sulfate allergy, hypermagnesemia, heart block, diabetes mellitus, systemic hypertension, cardiovascular or kidney disease, endocrine/metabolic disorders, and refusal to participate.

Randomization and intervention

Seventy participants were randomized using a computer-generated random number sequence into two equal groups. Group M ($n=35$) received magnesium sulfate 30 mg/kg diluted in 100 mL normal saline as a bolus over 5 minutes. Group S ($n=35$) received 100 mL of 0.9% normal saline over the same duration. The clinician administering the study drug and generating the random sequence was not

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involved in the study, supporting double blinding.

Monitoring and outcome measures

Heart rate, non-invasive blood pressure and oxygen saturation were recorded using multiparameter monitoring. Hemodynamic parameters were recorded every 5 minutes for the first 30 minutes and subsequently every 15 minutes until the end of surgery. Sedation was assessed using the six-point Ramsay Sedation Scale. Postoperative pain was assessed using a 0–10 visual analogue scale. Procedure-related and drug-related adverse events were documented.

Sample size and statistical analysis

Sample-size estimation was based on data from Paul et al. for mean arterial pressure at 15 minutes after pneumoperitoneum. The dissertation reports an estimated requirement of 31 patients per group at a 5% significance level and 90% power; 35 patients per group were planned to allow for approximately 10% attrition. Data were entered into Microsoft Excel 2016 and analyzed using IBM SPSS version 22. Continuous variables were compared using the unpaired t-test and categorical variables using Pearson's chi-square test. A p value <0.05 was considered statistically significant.

RESULTS

Baseline characteristics

All 70 enrolled patients were analyzed, with 35 participants in each group. The groups were comparable in age, weight, ASA physical status, comorbidities and regular medication use.

Variable	Group M (n=35)	Group S (n=35)	p value
Age, years	41.26 ± 8.67	41.74 ± 8.01	0.808
Weight, kg	70.94 ± 7.05	71.77 ± 7.06	0.625
ASA I, n (%)	25 (71.4)	24 (68.6)	0.794
ASA II, n (%)	10 (28.6)	11 (31.4)	0.794
No comorbidity, n (%)	25 (71.4)	24 (68.6)	0.992

Hemodynamic outcomes

Heart rate, systolic blood pressure and mean arterial pressure showed significant between-group differences at 15, 20 and 30 minutes. Diastolic blood pressure did not show a statistically significant difference at any assessed time point.

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Time	HR Group M	HR Group S	p	SBP Group M	SBP Group S	p
Baseline	87.34±11.16	86.37±8.34	0.681	125.46±11.3 5	124.54±9.71	0.718
Induction	81.46±10.35	83.94±14.75	0.417	113.20±14.0 2	114.69±9.07	0.600
5 min	80.77±9.61	85.26±11.69	0.084	113.54±16.6 7	116.46±13.7 0	0.427
10 min	81.23±8.44	85.49±10.71	0.069	116.14±14.0 5	123.03±15.5 2	0.056
15 min	79.69±9.26	84.74±11.17	0.043	115.17±11.1 8	127.00±17.9 7	0.002
20 min	78.54±9.87	84.77±11.48	0.018	114.31±9.93	128.43±17.5 0	0.001
30 min	78.43±8.98	85.57±10.43	0.003	116.49±9.54	128.91±15.6 1	0.001

Time	MAP Group M	MAP Group S	p	DBP Group M	DBP Group S	p
Baseline	96.46±9.14	92.51±7.82	0.057	82.63±8.96	80.00±7.17	0.180
Induction	87.29±10.33	84.66±8.01	0.238	74.89±10.26	73.03±7.85	0.397
5 min	86.77±11.49	85.86±11.94	0.745	74.94±11.92	70.97±11.44	0.160
10 min	89.23±11.48	90.63±12.67	0.630	76.23±11.85	74.97±11.63	0.656
15 min	83.89±20.74	93.74±13.92	0.023	76.06±9.95	77.63±12.33	0.559
20 min	88.57±8.72	94.63±13.33	0.028	76.00±9.44	78.26±11.71	0.378
30 min	88.91±8.43	94.91±12.22	0.020	75.74±8.66	78.37±10.93	0.269

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Postoperative pain, sedation and adverse events

Outcome	Group M (n=35)	Group S (n=35)	p value
VAS pain score	1.31 ± 0.47	2.63 ± 0.94	0.001
Ramsay Sedation Score	1.97 ± 0.51	1.94 ± 0.64	0.837
Procedure-related adverse events	0 (0%)	0 (0%)	Not applicable
Drug-related adverse events	0 (0%)	0 (0%)	Not applicable

DISCUSSION

The principal finding of this randomized double-blind study was that a 30 mg/kg intravenous bolus of magnesium sulfate was associated with lower heart rate, systolic blood pressure and mean arterial pressure during the later period following pneumoperitoneum, compared with normal saline. The effect was most evident from 15 minutes onward. Diastolic blood pressure did not differ significantly between groups. Magnesium sulfate was also associated with a lower postoperative pain score, while Ramsay sedation scores were similar.

The hemodynamic findings are consistent with several studies cited in the dissertation. Jee et al. reported attenuation of the arterial pressure response to pneumoperitoneum after magnesium administration, with reductions in catecholamine and vasopressin responses. Paul et al. similarly reported lower HR and MAP with magnesium during pneumoperitoneum. Bansal et al. found lower HR, SBP, DBP and MAP following magnesium administration. A systematic review and meta-analysis by Greenwood et al. reported consistent reductions in HR, SBP, DBP and MAP with intravenous magnesium sulfate across included randomized trials, although the review also emphasized

limitations related to small samples and selected patient populations.

In the present study, the absence of a significant DBP difference contrasts with some previous trials that demonstrated reductions in DBP. Differences in study population, magnesium dose, timing of administration, anesthetic technique and surgical procedure may contribute to variation between studies. The present trial used a 30 mg/kg bolus and included a mixed population of elective laparoscopic procedures rather than a single operation.

The reduction in postoperative pain score is consistent with the recognized analgesic properties of magnesium and with studies cited in the dissertation reporting lower postoperative pain following magnesium administration. The present study, however, assessed a single postoperative pain outcome rather than serial pain scores or total rescue analgesic consumption; therefore, the magnitude and duration of the analgesic effect cannot be determined beyond the measured outcome.

Ramsay Sedation Scores were similar between groups, suggesting that the study dose was not associated with a measurable difference in the assessed sedation score. No drug-related or procedure-related adverse events were recorded

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in either group. These findings should be interpreted in the context of the selected population and the sample size; absence of observed events does not establish absence of risk.

Strengths and limitations

Strengths include randomized allocation, double blinding, a prespecified comparator, standardized timing of hemodynamic measurements and assessment of both analgesic and sedation outcomes. Important limitations are the modest sample size, inclusion of only ASA I–II patients, exclusion of patients with major cardiovascular, renal and metabolic disease, use of convenience sampling, and limited hemodynamic observation during the first 30 minutes. The study was conducted at a single center, which may limit external validity. In addition, the dissertation does not provide sufficient detail in the manuscript-ready sections to characterize all laparoscopic procedures or standardize operative pneumoperitoneum pressures across procedures; these details should be added from the original case records/protocol if required by the target journal.

CONCLUSION

In adults undergoing elective laparoscopic surgery, intravenous magnesium sulfate at 30 mg/kg was associated with lower heart rate, systolic blood pressure and mean arterial pressure during the later period after pneumoperitoneum, and with lower postoperative pain scores compared with normal saline. Ramsay Sedation Scores were comparable and no procedure-related or drug-related adverse events were reported. These findings support further evaluation of intravenous magnesium sulfate as an adjunct for hemodynamic and analgesic management during laparoscopic surgery, particularly in larger and more clinically diverse populations.

REFERENCES

1. Soper NJ. Laparoscopic cholecystectomy the new “gold standard”? Arch Surg. 1992;127(8):917.
2. James MF, Beer RE, Esser JD. Intravenous magnesium sulfate inhibits catecholamine release associated with tracheal intubation. Anesth Analg. 1989;68(6):772–6.
3. Greenwood J, Nygard B, Brickey D. Effectiveness of intravenous magnesium sulfate to attenuate hemodynamic changes in laparoscopic surgery: a systematic review and meta-analysis. JBI Evid Synth. 2021;19(3):578–603.
4. Bansal K, Markandeshwar M, Garg U, Goel K, Vijay D, Tatineni V. Effect of intravenous magnesium sulphate on hemodynamic response to pneumoperitoneum in laparoscopic cholecystectomy: A prospective, double blind study. Anaesth Pain Intensive Care. 2019.
5. Telci L, Esen F, Akcora D, Erden T, Canbolat AT, Akpir K. Evaluation of effects of magnesium sulphate in reducing intraoperative anaesthetic requirements. Br J Anaesth. 2002;89(4):594–8.
6. Jee D, Lee D, Yun S, Lee C. Magnesium sulphate attenuates arterial pressure increase during laparoscopic cholecystectomy. Br J Anaesth. 2009;103(4):484–9.
7. Paul S, Biswas P, Bhattacharjee DP, Sengupta J. Effects of magnesium sulfate on hemodynamic response to carbon dioxide pneumoperitoneum in patients undergoing laparoscopic cholecystectomy. Anesth Essays Res. 2013;7(2):228–31.
8. Dar S, Gupta D, Deopujari R, Gomes P. Effect of Magnesium Sulphate on Attenuation of Hemodynamic Stress Responses during Laparoscopic Abdominal Surgeries. J Anesth Clin Res. 2015;6:590.

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9. Ghodratty M, Zamani M, Jamili S, Pournajafian A, Salemi P, Ghadrdoost B, et al. The effects of magnesium sulfate loading on hemodynamic parameters during laparoscopic cholecystectomy: Randomized controlled trial. *Arch Anesthesiol Crit Care*. 2017;3(2):313–8.
10. Maya, Ramya, Anzar, Gangadharan S. Effect of magnesium sulfate in attenuating arterial blood pressure in elective laparoscopic abdominal surgeries. *J Evol Med Dent Sci*. 2017;6(33):2680–3.
11. Zhang J, Wang Y, Xu H, Yang J. Influence of magnesium sulfate on hemodynamic responses during laparoscopic cholecystectomy: A meta-analysis of randomized controlled studies. *Medicine (Baltimore)*. 2018;97(45):e12747.
12. Tan W, Qian DC, Zheng MM, Lu X, Han Y, Qi DY. Effects of different doses of magnesium sulfate on pneumoperitoneum-related hemodynamic changes in patients undergoing gastrointestinal laparoscopy: a randomized, double-blind, controlled trial. *BMC Anesthesiol*. 2019;19(1):237.
13. Ishrat Z, Mehmood T, Akram RZ, Qamar N, Mushtaq I. Comparison of Magnesium Sulphate Vs Placebo for Hemodynamic Stability during Laparoscopic Cholecystectomy. *P J M H S*. 2020;14(1):227–31.
14. Das S, Basu S, Sasidharan S, Dhillon HS. The effects of magnesium sulphate on haemodynamic stress response to pneumoperitonium in laparoscopic cholecystectomy: a double blinded randomised controlled study. *Int J Adv Med*. 2021;8(7):872.
15. Zareen A, Gardazi SFA, Anwar MH, Zaheer J. Effects of IV Magnesium sulphate on hemodynamic response to pneumoperitoneum in laparoscopic cholecystectomy; A randomized control trial. *Ann Pak Inst Med Sci*. 2021;17(2):82–5.
16. Abd-Eldayem AMY, Abd-Eldayem OT, Ahmed MAE, Elsayed MAAE. Effect of magnesium sulphate on perioperative hemodynamic responses in hypertensive patients undergoing laparoscopic cholecystectomy: a randomized controlled double blinded trial. *Med J Cairo Univ*. 2022;90(3):647–56.
17. Rasheed E, Modak A, Verma N, Madavi S, Bhalerao N. Evaluation of the effects of intravenous magnesium sulphate on haemodynamic parameters in patients undergoing laproscopic cholecystectomy. *Medical Science*. 2022;26(123):1.
18. Akhondi M, Sarkoohi A. Effect of intravenous injection of magnesium sulphate on intraoperative end-tidal CO2 level and postoperative pain in laparoscopic cholecystectomy. *Anesth Pain Med*. 2023;13(6):e135189.
19. Chikkanarasimha RM, Rashmi RN, Nitturu VV, Nagaraj B, Swathi N. A comparative study of two different doses of magnesium sulfate on pneumoperitoneum-related hemodynamics and on the recovery in patients undergoing laparoscopic gynecological surgeries: a double-blind, randomized, clinical study. *Asian J Med Sci*. 2023;14(10):53–60.
20. Kumari R, Kumar A, Kumari B. To compare different doses of magnesium sulphate on hemodynamic changes in patients undergoing laparoscopic surgery. *Int J Curr Pharm Rev Res*. 2023;15(11):114–9.
21. Sravanthi GC, Abuji K, Soni SL, Nagaraj SS, Sharma A, Jafra A, et al. Effect of intraperitoneal magnesium sulfate in the prevention of postoperative pain in daycare laparoscopic cholecystectomy: a prospective randomized controlled trial. *Indian J Pharmacol*. 2023;55(3):174–8.
22. Ullah Khan R, Alam SA, Bilal M, Rahna A, Liaqat K, Iqbal J. Evaluation of the effects of

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magnesium sulphate versus normal saline on hemodynamics in patients undergoing laparoscopic cholecystectomy. J Islamabad Med Dental Coll. 2024;13(1).

23. Yaseen T, Rizvi SAM, Mahmood K, Malik U, Aziz M, Khan A. Analgesic effects of magnesium sulphate in patients undergoing laparoscopic cholecystectomy. Pak Armed Forces Med J. 2024.
24. The Ramsay sedation scale. MSD Manual Professional Edition. Accessed March 5, 2025.