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ORIGINAL ARTICLE

Comparison of the hemodynamic parameters of magnesium sulphate versus control group receiving normal saline in patients undergoing laparoscopic cholecystectomy using carbon dioxide pneumoperitoneum.

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ABSTRACT… Objective: To compare the haemodynamic parameters between magnesium sulphate and control group (experiencing laparoscopic cholecystectomy using carbon dioxide pneumoperitoneum) with normal saline. **Study Design:** Quasi-Experimental Study. **Setting:** Department of Anesthesia CMH Lahore. **Period:** 16-05-2025 to 16-11-2025. **Methods:** The sample size was 60 (30 in each group) patients aged between 18 and 50 years old who were ASA II or I, and underwent an elective laparoscopic cholecystectomy. Group A received intravenous magnesium sulphate (30 mg/Kg in 100 ml saline), and Group B received 100 ml of normal saline. Haemodynamic parameters were measured at premedication, postmedication at baseline, and at different periods during the operation, until the removal of the tube (HR and MAP). The SPSS 25.0 was applied to analyze the data; an independent sample t-test was applied with a p-value of less or equal to 0.05. **Results:** The gender distributions were the same in both groups; 40.0% of the members of Group A were male and 36.7 were female. In the Group B, the percentages were 60.0 and 63.3. The baseline of Group B of 99.0 ± 7.7 mmHg of the mean artery pressure (MAP) was similar to Group A 98.2 ± 7.4 mmHg ($p = 0.64$). After premedication, the MAP in group A was significantly lower (93.4 ± 6.9 vs. 97.8 ± 7.1 mmHg; $p = 0.01$) and this lower MAP continued to be observed during all the great periods. Group A recorded a mean arterial pressure (MAP) of 100.5 ± 7.8 mmHg after intubation and Group B reported a 112.6 ± 8.3 mmHg mean arterial pressure (MAP) ($p < 0.001$). All the differences, p-value (less than 0.001), were preceded by pneumoperitoneum (98.8 ± 7.6 vs. 110.2 ± 8.0 mmHg), 10 minutes (97.3 ± 7.2 vs. 109.3 ± 7.8 mmHg), 30 minutes (94.5 ± 6.6 vs. 105.8 ± 7.3 mmHg), and after extubation (92.3 ± 6.0 vs. 101.8 ± 6.8 mmHg). **Conclusion:** The perioperative hemodynamic stability of laparoscopic cholecystectomy is enhanced by the magnesium sulphate, which prevents the increase in heart rate and mean arterial pressure.

Key words: Cholecystectomy, Hemodynamics, Laparoscopy, Magnesium Sulphate, Mean Arterial Pressure, Pneumoperitoneum.

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INTRODUCTION

Cholecystitis refers to inflammation of a gallbladder caused by the blockage of cystic ducts caused by calculi, infection, neoplasm, or necrosis.[1] It usually presents with pain in the right upper quadrant, bloating, fever, and nausea which is mostly associated with the intake of food and the main management is surgery that involves cholecystectomy. Laparoscopic cholecystectomy has become the new norm of treatment due to so many advantages.[2] Carbon dioxide-induced pneumoperitoneum during laparoscopic cholecystectomy is associated with changes in haemodynamics that can be explained by hypercarbia, catecholamines, and vasopressin.[3]

The alterations are a reduction in the cardiac output (CO) and a rise in the systemic vascular resistance (SVR), heart rate (HR), and mean arterial pressure (MAP). Also, the Trendelenburg position inversed is used in the surgery, which significantly reduces the cardiac output, contributing to the haemodynamic changes. Long-term use of opioids, vasodilators and beta blockers have been used to avert the vasopressor response.[3] Magnesium is a non-opioid compound that can inhibit the secretion effect at adrenergic nerve endings and adrenal gland to release catecholamines.[4] Due to its various pharmacologic effects, magnesium sulphate has been studied with interest as a safe and inexpensive adjunct in laparoscopic surgery because of its ability to induce

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peripheral vasodilation, counteract vasoconstriction caused by vasopressin, attenuate pressor response to tracheal intubation and its antinociceptive effect.[5] It is especially useful in the case of laparoscopic cholecystectomy, due to its potential to reduce the sympathetic effect and ensure hemodynamic stability during the operation that involves a carbon dioxide pneumoperitoneum.[6,7]

In a study, the mean rate of heartbeat in magnesium sulphate group was found to be 81.50 + 8.44 beats per minute as compared to 93.03 + 6.93 beats per minute in the control group. Similarly, the mean arterial pressure (MAP) was 98.43 ± 10.29 mmHg in patients receiving magnesium sulphate versus 113.27 ± 9.16 mmHg in the control group. A significant reduction in both heart rate and mean arterial pressure was observed in the magnesium sulphate group from baseline until extubation.[8]

We assume that intravenous magnesium sulphate may reduce the negative effect on adverse hemodynamics, including elevated heart rate and mean arterial pressure, in laparoscopic cholecystectomy with carbon dioxide pneumoperitoneum. Its sympatholytic and vasodilatory effects can be beneficial in ensuring cardiovascular stability in the course of the surgery. Its presence in the literature is justified in a number of surgeries, but little information is found in our local population. This paper will test its effectiveness in our clinical environment. In case it is proven to be effective, it can enhance the quality of anesthesia and decrease the use of other pharmacological agents. The results will add good information to the existing body of knowledge.

METHODS

This quasi-experimental study was conducted in CMH Lahore anaesthesia complex with the approval of the institutional ethical council (RRBN, 485/2023). The sample size of 60 cases (30 per group) was calculated using calculator (www.openepi.com) based on 95% confidence interval and 5% margin of error based on the mean HR of 81.50+8.4 in the MgSo4 group and 93 +6.9 in the control group.[8] The sampling was done by a non-probability sampling technique. The inclusion criteria included patients with an ASA rating of I or II (no matter their gender) and a span between 18 to 50 years of age who are going to do an elective laparoscopic cholecystectomy. The exclusion criteria included patients with known hypersensitivity to magnesium sulphate, as well as those with a history of cardiovascular, pulmonary, hepatic, renal, endocrine, or neurological disorders. Additionally, patients on antipsychotic medications were also excluded from the study. Group A: Patients were premedicated with an intravenous infusion of magnesium sulphate at a dose of 30 mg/kg diluted in normal saline to a total volume of 20 ml, administered over 15 minutes. Group B: Patients were given normal saline (control) in the same quantity.

All patients were made to avoid any oral medication at least eight hours before surgery. During the surgical procedure, they were shifted to the operating table. After securing wide-bore intravenous access and attaching noninvasive monitoring for HR & MAP, patients were pre-oxygenated and pre-medicated as per standard protocol. Before induction, both groups were administered their respective study drugs. Standardized general anesthesia in both groups was induced using intravenous injection of propofol (2 mg/kg) intravenously. Once confirmed effective bag-mask ventilation, Inj. Atracurium (0.5 mg/kg) was administered for muscle paralysis. After the laryngoscopy, endotracheal intubation was done and confirmed through capnography and bilateral chest auscultation. Mechanical ventilation was started. The maintenance done intraoperative was O2, Isoflurane, and intermittent muscle relaxant doses. After establishing CO 2 pneumoperitoneum, intra-abdominal pressure was kept at 12 mmHg during the procedure whereby the ETCO 2 target was set between 25 and 30 mmhg. CR and MAP were manually noted after every 10 minutes, beginning with the baseline, after induction and positioning, after the creation of the pneumoperitoneum, and so forth. Heart rate (HR) and mean arterial pressure (MAP) were measured at baseline and different time intervals following the establishment of pneumoperitoneum up to the extubation procedure between Group A (was given magnesium sulphate) and Group B (control group was given normal saline). Any baseline to baseline variation in both parameters exceeding 20 percent was identified and attended to at the moment as an indicator of hemodynamic instability. The patients were extubated with the doses of neostigmine and glycopyrrolate accepted as standard once the insufflated gas was fully removed at the port sites. Upon full consciousness, they were transferred to the Post Anesthesia Care Unit (PACU) and evaluated on adverse effects of the subsequent operation.

The data was analysed using SPSS version 25.0. Per cent and frequencies described quantitative characteristics, meaning gender and ASA status. Numerical variables, including patient age, weight, duration of surgery, MAP, and HR, were expressed as mean ± standard deviation. Comparison in two groups in terms of MAP and heart rate was performed using the independent samples t-test. Data was stratified by age, gender, BMI, ASA Physical status post-stratification t-test was applied.

RESULTS

Group A and Group B had a similar age of patients with 46.7% and 43.3% of the patients, respectively, falling within the 18–35 years age category, and 53.3% vs. 56.7% in the 36–50 years group, respectively. Gender distribution was also similar between the groups, with males comprising 40.0% in Group A and 36.7% in Group B, and females making up 60.0% and 63.3%, respectively. The mean body weight was 67.2 ± 8.5 kg in Group A and 66.5 ± 9.2 kg in Group B ($p = 0.71$). BMI categories showed that 40.0% of patients in Group A and 36.7% in Group B had a BMI less than 25 (normal), whereas 60.0% and 63.3%, respectively, were categorized as overweight or obese (BMI ≥ 25), with no statistically significant difference as given in Table-I.

Table-II indicates that at baseline, the heart rate of Group A (85.1 ± 6.8 bpm) and Group B (86.3 ± 7.1 bpm; $p = 0.48$) were similar. Notable differences were observed after intubation (88.2 ± 7.5 vs. 97.4 ± 8.0; $p < 0.001$), 10 minutes after pneumoperitoneum (84.3 ± 6.9 vs. 96.5 ± 7.4; $p < 0.001$), and after extubation (79.2 ± 6.2 vs. 90.4 ± 6.6; $p < 0.001$).

Table-III shows that mean arterial pressure (MAP) at baseline was similar in Group A (98.2 ± 7.4 mmHg) and Group B (99.0 ± 7.7 mmHg; $p = 0.64$). However, after premedication, MAP was significantly lower in Group A (93.4 ± 6.9 vs. 97.8 ± 7.1; $p = 0.01$) and remained significantly reduced throughout all subsequent intervals. After intubation, Group A had a MAP of 100.5 ± 7.8 mmHg compared to 112.6 ± 8.3 mmHg in Group B ($p < 0.001$). The difference persisted before pneumoperitoneum (98.8 ± 7.6 vs. 110.2 ± 8.0), at 10 minutes (97.3 ± 7.2 vs. 109.3 ± 7.8), 30 minutes (94.5 ± 6.6 vs. 105.8 ± 7.3), and after extubation (92.3 ± 6.0 vs. 101.8 ± 6.8), all with $p < 0.001$.

Table-IV indicates that, on stratification on age, gender, BMI and ASA status, the mean heart rate was significantly low in Group A versus Group B in all subgroups ($p < 0.001$). This steady decrease proves the efficacy of magnesium sulphate in managing heart rate irrespective of demographical and clinical factors.

According to Table-V, mean arterial pressure (MAP) was significantly lower in Group A between all of the stratified subgroups of age, gender, BMI, and ASA status ($p < 0.001$). This steady decrease shows that magnesium sulphate was equally effective in the control of MAP despite patient demographics and clinical status.

TABLE-I

Demographics and Clinical Characteristics of patients (n = 60) at baseline

Age (years)			
18–35 years	14 (46.7%)	13 (43.3%)	0.83
36–50 years	16 (53.3%)	17 (56.7%)	
Gender			
Male	12 (40.0%)	11 (36.7%)	0.50
Female	18 (60.0%)	19 (63.3%)	
BMI (kg/m²)			
Weight	67.2 ± 8.5	66.5 ± 9.2	0.71
< 25 (Normal)	12 (40.0%)	11 (36.7%)	0.98
≥ 25 (Overweight/ Obese)	18 (60.0%)	19 (63.3%)	
ASA Status			
ASA I	21 (70.0%)	20 (66.7%)	0.78
ASA II	9 (30.0%)	10 (33.3%)	

TABLE-II

Comparison of mean heart rate in a given set to a given period

Time Interval	Group A (Magnesium)	Group B (Control)	P-Value
Baseline	85.1 ± 6.8	86.3 ± 7.1	0.48
After premedication	79.6 ± 6.4	85.2 ± 6.7	0.002
After intubation	88.2 ± 7.5	97.4 ± 8.0	<0.001
Before pneumoperitoneum	86.0 ± 7.2	95.3 ± 7.6	<0.001
10 mins after pneumoperitoneum	84.3 ± 6.9	96.5 ± 7.4	<0.001
20 mins	82.6 ± 6.7	94.7 ± 7.2	<0.001
30 mins	81.4 ± 6.5	92.8 ± 6.9	<0.001
40 mins	80.6 ± 6.3	91.6 ± 6.8	<0.001
60 mins	79.8 ± 6.1	90.7 ± 6.5	<0.001
90 mins	78.6 ± 6.0	89.5 ± 6.3	<0.001
After release of pneumoperitoneum	77.9 ± 5.8	88.2 ± 6.1	<0.001
After extubation	79.2 ± 6.2	90.4 ± 6.6	<0.001

TABLE-III

Comparison of the group mean arterial pressure (mmHg) at various time intervals

Time Interval	Group A (Magnesium)	Group B (Control)	P-Value
Baseline	98.2 ± 7.4	99.0 ± 7.7	0.64
After premedication	93.4 ± 6.9	97.8 ± 7.1	0.01
After intubation	100.5±7.8	112.6 ± 8.3	<0.001
Before pneumoperitoneum	98.8 ± 7.6	110.2 ± 8.0	<0.001
10 mins after pneumoperitoneum	97.3 ± 7.2	109.3 ± 7.8	<0.001
20 mins	95.6 ± 6.9	107.4 ± 7.5	<0.001
30 mins	94.5 ± 6.6	105.8 ± 7.3	<0.001
40 mins	93.7 ± 6.3	104.6 ± 7.1	<0.001
60 mins	92.8 ± 6.1	103.2 ± 6.9	<0.001
90 mins	91.9 ± 5.9	102.1 ± 6.7	<0.001
After release of pneumoperitoneum	90.6 ± 5.6	100.7 ± 6.5	<0.001
After extubation	92.3 ± 6.0	101.8 ± 6.8	<0.001

TABLE-IV

Findings of a Post-stratification Comparison of mean HR in Beats per minute

Variable	Subcategory	Group A (Mean ± SD)	Group B (Mean ± SD)	P-Value
Age	18–35 years	81.4 ± 6.2	92.3 ± 6.5	<0.001
	36–50 years	82.1 ± 6.0	91.5 ± 6.7	<0.001
Gender	Male	82.2 ± 6.5	91.4 ± 6.8	<0.001
	Female	81.6 ± 6.3	92.0 ± 6.5	<0.001
BMI (kg/m^2)	< 25 (Normal)	80.9 ± 6.4	91.0 ± 6.6	<0.001
	≥ 25 (Overweight/Obese)	82.3 ± 6.2	92.4 ± 6.7	<0.001
ASA Status	ASA I	81.8 ± 6.4	91.8 ± 6.7	<0.001
	ASA II	82.0 ± 6.1	91.5 ± 6.4	<0.001

TABLE-V

Comparison of Mean Arterial Pressure (MAP) Post-Stratification (mmHg)

Variable	Subcategory	Group A (Mean ± SD)	Group B (Mean ± SD)	P-Value
Age	18–35 years	94.2 ± 6.5	105.6 ± 6.9	<0.001
	36–50 years	94.8 ± 6.8	106.1 ± 7.1	<0.001
Gender	Male	94.4 ± 6.3	105.4 ± 6.7	<0.001
	Female	94.6 ± 6.6	106.0 ± 6.8	<0.001
BMI (kg/m^2)	< 25 (Normal)	94.0 ± 6.7	105.8 ± 6.6	<0.001
	≥ 25 (Overweight/Obese)	94.9 ± 6.4	105.6 ± 6.9	<0.001
ASA Status	ASA I	94.7 ± 6.5	105.9 ± 6.7	<0.001
	ASA II	94.2 ± 6.6	105.6 ± 6.8	<0.001

DISCUSSION

The conventional management of gallstone disease is laparoscopic cholecystectomy which induces severe hemodynamic alterations as a result of carbon dioxide pneumoperitoneum. These modifications encompass high heart rate (HR) and mean arterial pressure (MAP), which can be dangerous particularly in weakened patients.[9,10] The non-opioid agent magnesium sulphate affects these responses by vasodilatation and sympatholysis. It reduces the release of catecholamines, as well as enhancing cardiovascular stability in the operating room.[11,12]

We also discovered that intravenous magnesium sulphate (30 mg/kg) significantly decreased the acceleration in heart rate and mean arterial pressure (MAP) at all the intraoperative time points, as compared to the normal saline ($p < 0.001$). Similar results were also found by Khan et al. (2024) who did not find significant differences in baseline hemodynamic parameters, which confirms the first comparability of groups in our study.[13] These results are consistent with some of the published trials assessing the utilization of magnesium sulphate in laparoscopic operations. Similar to our findings, Paul et al. (2023) observed much lower HR and MAP during pneumoperitoneum in magnesium group, where 40 percent of the patients in the control condition had to be placed on labetalol in order to control intraoperative hypertension- a clinical advantage of magnesium sulphate.[14]

Shafiq et al. (2022) also observed significant reductions in HR (80.8 ± 4.5 vs. 87.7 ± 5.0 bpm; $p < 0.001$), systolic BP (133.3 ± 8.2 mmHg) and diastolic BP (77.6 ± 6.7 mmHg) were significantly different from each other ($p < 0.001$) after 30 minutes of pneumoperitoneum with magnesium use, which is consistent with our observed HR and MAP reductions from 10 to 90 minutes.[15] We also find the same result as Zareen et al. (2021), who also found much lower HR and BP at the critical intraoperative points ($p < 0.05$).[16] In addition to this, Jee et al. (2020) gave physiological evidence by demonstrating reduced vasopressin, norepinephrine, and epinephrine in magnesium group in the hemodynamic stabilization of our study that was mechanistically underpinning.[17] Conversely, Bagle et al. (2022) did not find any significant difference in HR or BP between groups ($p > 0.05$), but both groups sustained changes within 20% of baseline.[18] Bansal et al. (2021), who also found significant reductions in HR (81.50 93.03/ min vs. 98.43 113.27mmHg) and MAP (98.43 113.27mmHg vs. 10 minutes post.[19] The results of Shameem et al. (2022) are also consistent with our results, showing that the positive differences in hemodynamics in control groups and better MAP and vascular resistance in intervention groups have significant values.[20]

In this way, we have solid evidence that intravenous magnesium sulphate can be used in reducing intraoperative variation in hemodynamics in laparoscopic cholecystectomy as a safe and effective agent. The performance that has been demonstrated by it repeatedly in various studies identifies its reliability, especially in the resource-limited environments where other agents might be more expensive or not available. There was no evaluation of long-term postoperative outcomes and recovery data. The results cannot be extended to patients with severe comorbidities.

CONCLUSION

In laparoscopic cholecystectomy, magnesium sulphate played a major role in suppressing the increase of heart rate and mean arterial pressure. It turned out to be a useful and safe adjunct in terms of hemodynamic control. Its daily application would help improve perioperative cardiovascular stability in comparable surgical practice.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Naveera Iftikhar:** Study design, conception of idea.
2	**Muhammad Ehsan Zafar:** Interpreted data.
3	**Muhammad Shoaib Afzal Khan:** Data collection.
4	**Zerwah Mohammad Qayyum:** Data anlaysis.
5	**Hammad Rafique:** Critical revisions.
6	**Hafsa Rasheed:** Proof reading.