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Effect of Preinduction Single-Dose Intravenous Magnesium Sulphate on Haemodynamic Response to Pneumoperitoneum in Patients Undergoing Laparoscopic Cholecystectomy.

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Abstract

Background: Creation of pneumoperitoneum during laparoscopic surgery produces significant sympathetic stimulation, resulting in tachycardia and hypertension. These haemodynamic alterations may be detrimental, especially in patients with limited cardiovascular reserve. Magnesium sulphate, owing to its calcium antagonist and N-methyl-D-aspartate (NMDA) receptor antagonist properties, has been shown to attenuate stress responses during surgery. However, evidence regarding the efficacy of a single preinduction dose is limited. ***Aim:*** To evaluate the effect of a single preinduction intravenous dose of magnesium sulphate on haemodynamic responses to pneumoperitoneum in patients undergoing laparoscopic cholecystectomy under general anaesthesia. ***Materials and Methods:*** A prospective, randomized, double-blind study was conducted on 60 ASA physical status I and II patients scheduled for elective laparoscopic cholecystectomy. Patients were randomly allocated into two groups of 30 each. Magnesium Group (MG): Received magnesium sulphate 50 mg/kg diluted in 100 mL normal saline over 10 minutes before induction. Control Group (CG): Received 100 mL normal saline over 10 minutes before induction. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were recorded before induction, before pneumoperitoneum, and every five minutes after creation of pneumoperitoneum until completion of surgery. Adverse effects were also noted. ***Results:*** Demographic characteristics were comparable between the groups. Patients receiving magnesium sulphate demonstrated significantly lower HR, SBP, DBP, and MAP following pneumoperitoneum compared with the control group ($p<0.001$). No major adverse effects attributable to magnesium sulphate were observed. ***Conclusion:*** A single preinduction intravenous dose of magnesium sulphate (50 mg/kg) effectively attenuates haemodynamic responses associated with pneumoperitoneum during laparoscopic cholecystectomy and may be considered a useful adjunct during general anaesthesia.

Keywords: Magnesium sulphate, Pneumoperitoneum, Laparoscopic cholecystectomy, Haemodynamic response, General anaesthesia, Postoperative analgesia.

INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard treatment for symptomatic gallstone disease owing to reduced postoperative pain, shorter hospital stay, and faster recovery compared to open surgery. Nevertheless, the creation of carbon dioxide pneumoperitoneum is associated with marked cardiovascular changes resulting from increased intra-abdominal pressure and neurohumoral activation.

Pneumoperitoneum causes an increase in systemic vascular resistance, mean arterial pressure, and heart rate through stimulation of the sympathetic nervous system and release of catecholamines and vasopressin. These haemodynamic responses may be well tolerated in healthy individuals but can precipitate myocardial ischemia, arrhythmias, or heart failure in susceptible patients.

Various pharmacological agents including opioids, beta blockers, calcium channel blockers, clonidine, dexmedetomidine, nitroglycerin, and magnesium sulphate have been investigated to attenuate these responses.

Magnesium sulphate acts as a physiological calcium antagonist, inhibits catecholamine release from adrenal medulla and peripheral nerve endings, causes vasodilation, and antagonizes NMDA receptors, thereby reducing nociception and

sympathetic stimulation. Although continuous magnesium infusion has shown favourable results, studies evaluating the efficacy of a single preinduction dose remain limited.

The present study was undertaken to evaluate whether a single intravenous dose of magnesium sulphate administered before induction can effectively attenuate haemodynamic responses during pneumoperitoneum.

Aim and Objectives

Primary Objective

To evaluate the effect of preinduction intravenous magnesium sulphate on haemodynamic responses during pneumoperitoneum.

Secondary Objectives

- To compare heart rate between the groups.
- To compare SBP, DBP and MAP.
- To observe adverse effects.
- To assess postoperative analgesic requirement.

MATERIALS AND METHODS

Study Design

Prospective randomized double-blind controlled study.

Study Population

Sixty adult patients posted for elective laparoscopic cholecystectomy.

Inclusion Criteria

- Age 18–60 years
- ASA Grade I and II
- Elective laparoscopic cholecystectomy

Exclusion Criteria

- Hypertension
- Ischaemic heart disease
- Renal dysfunction
- Hepatic dysfunction
- Neuromuscular disorders
- Pregnancy
- Magnesium allergy

Patients were randomized using computer-generated random numbers into two equal groups.

Group MG (n=30)

Magnesium sulphate 50 mg/kg diluted in 100 mL normal saline infused over 10 minutes before induction.

Group CG (n=30)

100 mL normal saline infused over 10 minutes before induction.

Standard general anaesthesia was administered in both groups.

Haemodynamic variables were recorded:

- Baseline
- Before pneumoperitoneum
- 5 minutes
- 10 minutes
- 15 minutes
- 20 minutes
- End of surgery

Statistical Analysis

Data were analysed using SPSS software.

Continuous variables were expressed as Mean ± Standard Deviation.

Student's t-test was used for comparison between groups.

Repeated measures ANOVA was used for serial haemodynamic measurements.

Categorical variables were analysed using Chi-square test.
P value <0.05 was considered statistically significant.

RESULTS

Table 1. Demographic Characteristics

Variable	Magnesium Group	Control Group	P value
Age (years)	44.7 ± 9.46	42.6 ± 8.24	>0.05
Gender (M/F)	14/16	12/18	>0.05
Weight (kg)	52.24 ± 8.24	53.82 ± 6.82	>0.05
ASA I/II	18/12	17/13	>0.05
Duration of surgery (min)	46.4 ± 6.34	44.86 ± 4.34	>0.05

Table 2. Heart Rate

Time	Magnesium Group (Mean ± SD)	Control Group (Mean ± SD)	P value
Baseline	82.4 ± 7.2	83.1 ± 6.8	NS
Beforepneumoperitoneum	84.6 ± 6.8	85.2 ± 7.4	NS
5 minutes	86.2 ± 7.6	98.4 ± 8.8	<0.001
10 minutes	82.8 ± 6.4	95.6 ± 9.2	<0.001
15 minutes	83.6 ± 6.2	96.8 ± 8.6	<0.001
20 minutes	84.2 ± 6.8	97.4 ± 9.4	<0.001

Table 3. Systolic Blood Pressure

Time	Magnesium Group (Mean ± SD)	Control Group (Mean ± SD)	P value
Baseline	122.4 ± 8.6	124.1 ± 9.2	NS
Before pneumoperitoneum	126.2 ± 9.1	127.8 ± 8.8	NS
5 minutes	128.4 ± 8.4	142.6 ± 10.8	<0.001
10 minutes	122.6 ± 7.8	138.4 ± 11.2	<0.001
15 minutes	123.8 ± 8.2	140.2 ± 10.6	<0.001
20 minutes	124.6 ± 8.4	141.4 ± 11.0	<0.001

Table 4. Diastolic Blood Pressure

Time	Magnesium Group (Mean ± SD)	Control Group (Mean ± SD)	P value
Baseline	74.8 ± 5.2	76.4 ± 5.8	NS
Before pneumoperitoneum	81.6 ± 6.4	82.2 ± 6.8	NS
5 minutes	82.4 ± 6.2	90.8 ± 8.2	<0.001
10 minutes	76.8 ± 5.8	87.6 ± 7.8	<0.001
15 minutes	78.2 ± 5.6	89.4 ± 7.6	<0.001
20 minutes	79.4 ± 6.2	90.2 ± 8.0	<0.001

Table 5. Mean Arterial Pressure

Time	Magnesium	Control	P value
Baseline	90.2± 4.4	92.3± 6.6	NS
Before pneumoperitoneum	96.4± 7.4	97.2± 8.6	NS
5 min	97.6± 7.4	108± 11.6	<0.001
10 min	90.6± 6.8	104± 12.4	<0.001
15 min	92.4± 4.8	106± 10.2	<0.001
20 min	93.6± 7.8	107± 12.4	<0.001

Table 6. Adverse Effects

Complication	Magnesium	Control
Hypotension	1	0
Bradycardia	0	0
Arrhythmia	0	0
Nausea/Vomiting	0	0

DISCUSSION

The present study evaluated the efficacy of a single preinduction intravenous dose of magnesium sulphate in attenuating haemodynamic responses to pneumoperitoneum during laparoscopic cholecystectomy. The findings demonstrated significantly lower heart rate and blood pressure values in patients receiving magnesium sulphate compared with the control group, indicating effective attenuation of sympathetic responses.

The demographic characteristics of both groups were comparable, minimizing potential confounding factors.
The observed attenuation of haemodynamic responses can be explained by the pharmacological properties of magnesium. Magnesium inhibits calcium influx into vascular smooth muscle cells, producing vasodilation. It also suppresses catecholamine release from adrenergic nerve terminals and the adrenal medulla and acts as an NMDA receptor antagonist, thereby reducing sympathetic activation and nociceptive transmission.

The findings of the present study are consistent with those reported by Jee et al. (2009), who demonstrated that intravenous magnesium sulphate significantly reduced arterial pressure increases during laparoscopic cholecystectomy compared with placebo. Their study concluded that magnesium provided better haemodynamic stability without significant adverse effects. Similarly, Junghans et al. (2006) systematically evaluated different methods of minimizing haemodynamic alterations during pneumoperitoneum and emphasized that pharmacological attenuation of sympathetic responses improves intraoperative cardiovascular stability. Magnesium sulphate was identified as one of the promising agents due to its vasodilatory and sympatholytic effects.

Our findings also agree with Telci et al. (2002), who demonstrated that magnesium infusion reduced anaesthetic requirements and improved perioperative haemodynamic stability in patients undergoing major surgery. Koinig et al. (1998) reported reduced postoperative analgesic requirements following perioperative magnesium administration because of NMDA receptor antagonism. Although postoperative analgesia was not the primary outcome of the present study, the analgesic properties of magnesium may provide an additional clinical advantage.

Likewise, Ryu et al. (2008) found that magnesium sulphate attenuated cardiovascular responses during laparoscopic surgery and reduced perioperative opioid consumption. No clinically significant adverse effects such as severe hypotension, bradycardia, respiratory depression, or delayed recovery were observed in the magnesium group, supporting the safety of a single preinduction dose of 50 mg/kg in ASA I and II patients.

The present study therefore reinforces the role of magnesium sulphate as a simple, inexpensive, and effective adjunct for maintaining haemodynamic stability during laparoscopic surgery.

Limitations

- Small sample size.
- Single-centre study.
- Only ASA I and II patients were included.
- Serum magnesium levels were not measured.
- Postoperative pain scores and analgesic consumption were not analysed in detail.

CONCLUSION

Administration of a single intravenous dose of magnesium sulphate (50 mg/kg) before induction significantly attenuated the haemodynamic responses associated with pneumoperitoneum during laparoscopic cholecystectomy. Magnesium sulphate maintained heart rate and arterial blood pressure closer to baseline values without significant adverse effects. Owing to its efficacy, safety, ease of administration, and low cost, magnesium sulphate can be considered a useful adjunct in general anaesthesia for laparoscopic procedures.

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