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Effect of Magnesium Sulphate on Attenuation of Hemodynamic Stress Responses during Laparoscopic Abdominal Surgeries

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Abstract

Introduction: This randomized, double-blind, prospective study was undertaken to evaluate the effect of magnesium sulphate in attenuating the stress responses associated with laparoscopic abdominal surgeries.

Methods: 62 patients who underwent laparoscopic abdominal surgery were randomly divided in to two groups, group I and group II. 5 minutes after intubation but before creation of pneumoperitoneum, the magnesium group (group I) received magnesium sulphate 50 mg/kg diluted in normal saline to total volume of 20 ml at 240 ml/hour over 5 minutes. The control group (group II) received same amount of normal saline.

Results: Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure were significantly less in group I with p<0.05. Train of four had no statistical significance. Extubation time was more in Group I but had no statistical significance.

Conclusion: magnesium sulphate attenuates hemodynamic stress response in laparoscopic abdominal surgeries.

Keywords: Hemodynamic changes; Magnesium sulphate; Laparoscopic abdominal surgeries; Extubation time

Introduction

Early in the 20th century, diagnostic laparoscopy was used by a limited number of general surgeons in place of diagnostic laparotomy, but had a substantial complication rate [1]. First laparoscopic cholecystectomy was performed by a French gynaecologist Mouret in 1987 with the help of four trocars [2].

Laparoscopic surgical procedures aim to achieve a satisfactory therapeutic result while minimizing the traumatic and metabolic stress of the intervention. Tissue trauma is significantly less than conventional open procedures, thus results in less postoperative pain. Other advantages include smaller incisional sites, lower risks of wound complications, shorter hospital stay, more rapid return to normal activities, and cost saving [3]. Pneumoperitoneum required for the smooth conduct of laparoscopy, affects homeostasis and leads to alterations in cardiovascular, pulmonary physiology and stress response. Cardiovascular changes include increase in mean arterial pressure (MAP) with no significant change in heart rate [4], decrease in cardiac output and increase in systemic vascular resistance. The mechanism of the decrease cardiac output is multifactorial [5,6].

Various surgical methods like change in nature of insufflating gas [7], use of low intra-abdominal pressure [8,9], use of abdominal wall lift methods [10], have been tried to decrease the hemodynamic alterations seen with pneumoperitoneum, but all with practical limitations. Various anaesthetic interventions like use of epidural, segmental spinal [11], combined epidural and general anesthesia [12], use of various pharmacologic interventions like nitroglycerine [13], esmolol [14], have been used with varying success and practical limitations.

Magnesium blocks release of catecholamine from both adrenergic nerve terminals and adrenal gland [15]. Intravenous magnesium sulphate inhibits catecholamine release associated with intubation [16]. Magnesium also produces vasodilatation by acting directly on blood vessels [17], and in high doses, attenuates vasopressin mediated vasoconstriction [18].

Materials and Methods

After obtaining approval from hospital Ethical Committee, details of the procedure was explained to the patients and a written informed consent was taken. 62 ASA I or II patients undergoing laparoscopic abdominal surgery were enrolled into the study. Exclusion criteria were; known allergy to any drug in study, cardiovascular disease, asthma, body weight >75 kgs, hypermagnesemia, kidney disease, endocrine and metabolic disease, diabetes mellitus, and patients on calcium channel blockers.

Patients were randomly divided into two groups according to computer generated randomization table. A patient received one of these solutions as a bolus intravenously 5 minutes after intubation but before pneumoperitoneum was created.

Group I: (Magnesium group) received magnesium sulphate 50 mg/kg 5 minutes after intubation over a period of 5 minutes diluted in normal saline to total volume 20ml @ 240 ml/hr through infusion pump but before pneumoperitoneum was created.

Group II: (control group) received 20 ml of normal saline @ 240 ml/hr through infusion pump 5 minutes after intubation over a period of 5 minutes but before pneumoperitoneum was created.

On the night prior to surgery all patients received tab Pantoprozole 40 mg & Tab Alprazolam 0.5 mg orally as premedication and patients were kept nil by mouth 6 hrs prior to surgery.

On arrival in the operating room, after confirming the identity of the patient, the consent was checked; the preoperative assessment was reviewed and up dated. The nil by mouth status of the patient was confirmed. Anesthesia machine, monitors and resuscitation equipments were checked. ECG, NIBP and pulse oximeter were applied and baseline readings of parameters like HR, SBP, DBP, MAP and SpO_2 were noted. Capnometer ($ETCO_2$) was attached after intubation.

All patients received premedication injection midazolam 0.02 mg/kg, injection fentanyl 2 µg/kg, and injection Glycopyrolate 4 µg/kg body weight intravenous.

Patients were pre-oxygenated with 100% O_2 for 3 minutes before induction. Induction was done with Inj. Propofol 2 mg/kg body weight i.v in both the groups and injection Rocuronium 0.8 mg/kg iv to facilitate endotracheal intubation. Bilateral air entry was confirmed by auscultation, $ETCO_2$ reading noted and the endotracheal tube was firmly secured using adhesive tape.

Anesthesia was maintained with oxygen and nitrous oxide mixture 50:50, sevoflurane end- tidal 1.5 to 2.5% and rocuronium 0.2 mg/kg intermittent boluses.

During surgery ringer lactate was infused in accordance with deficit, maintenance and blood loss. CO_2 pneumoperitoneum was created and intra-abdominal pressure maintained between 12-14 mm Hg. Patients were ventilated mechanically. Tidal volume and respiratory rate were adjusted to maintain end-tidal CO_2 between 35-45mm Hg. Monitoring of HR, SBP, DBP, MBP, SpO_2, $ETCO_2$ and TOF was done on a multi-channel monitor and TOF monitor. All patients were given injection ondanseteron 4mg, injection diclofenac sodium 75mg intravenous towards the end of surgery.

Reversal and Extubation

After completion of surgery and achieving complete haemostasis and placement of dressing at the site of surgery, residual neuromuscular blockade was reversed with a combination of Injection Neostigmine 0.05 mg/kg and Injection Glycopyrrolate 8 µg/kg. Sevoflurane and nitrous Oxide were discontinued once last suture was applied. 100% Oxygen was administered. The patients were extubated once TOF was between 90 % to 100%. Extubation time was noted. All patients were monitored for 30 minutes in recovery room following extubation.

Monitoring and recording of parameters was done at following intervals and analyzed for study.

- Baseline vitals (Average of 3 readings pre-operative).
- Five minutes after intubation.
- Five minutes after infusion of drug.
- Before creation of pneumoperitoneum.
- 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, and 60 minutes after pneumoperitoneum

Statistical Analysis

After data collection, data entry was done in Excel. Data analysis was done with the help of SPSS Software ver 15 and Sigmaplot Ver 11.

Quantitative data is presented with the help of Mean, Std Dev, Median and IQR, comparison between study groups is done with the help of Unpaired t-test or Mann-Whitney test as per results of Normality test. Qualitative data is presented with the help of Frequency and Percentage table, association among study group is assessed with the help of Chi-Square test. p-value less than 0.05 is taken as significant level.

Results

The patient characteristics are described in table 1.

	Group I	Group II
Age (yrs)	37.97 ± 10.77	38.16 ± 8.43
Weight (kg)	59.19 ± 7.62	61.77 ± 8.28
M/F	3/28	3/28

Table 1: patient characteristics.

There was no significant difference in the base line pulse rate, systolic, diastolic and mean arterial pressure (Table 2).

	Group I	Group II	p value
PR	91.39 ± 16.74	89.32 ± 15.18	0.613
SBP	124.35 ± 18.89	125.26 ± 15.81	0.839
DBP	78.26 ± 22.59	74.87 ± 9.56	0.445
MAP	86.81 ± 9.87	87 ± 10.14	0.94

Table 2: Baseline vitals.

Heart rate in group I was lower than group II throughout the study period but was statistically significant at 10 minutes after pneumoperitoneum ($p<0.05$). Systolic blood pressure, Diastolic blood pressure, Mean arterial pressure was low in group I than group II throughout the study period and were statistically significant ($p<0.05$) (Figures 1-4).

There was no statistical significant difference in TOF between the two groups. Extubation time was more in group I than group II but was not statistically significant. No case of bradycardia was noted in either group.

Discussion

This placebo controlled, double blind study was designed to assess the effects of magnesium sulphate on attenuation of hemodynamic stress responses during laparoscopic abdominal surgeries.

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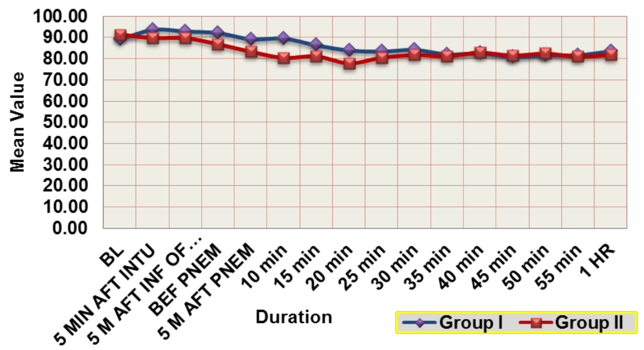

Figure 1: Comaprison of PR (per min) at various duaration among study group.

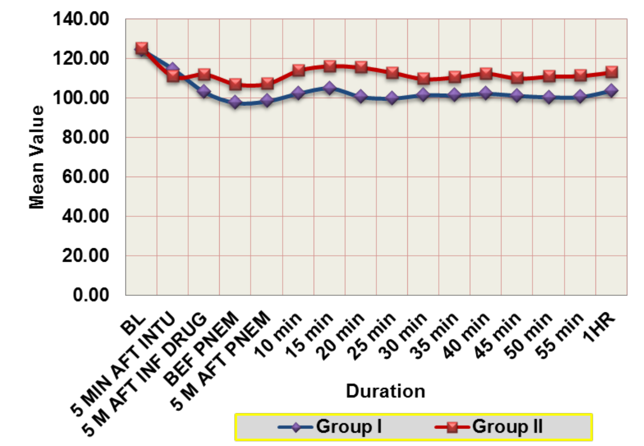

Figure 2: Comparison of SBP (mmHg) at various duration among study groups.

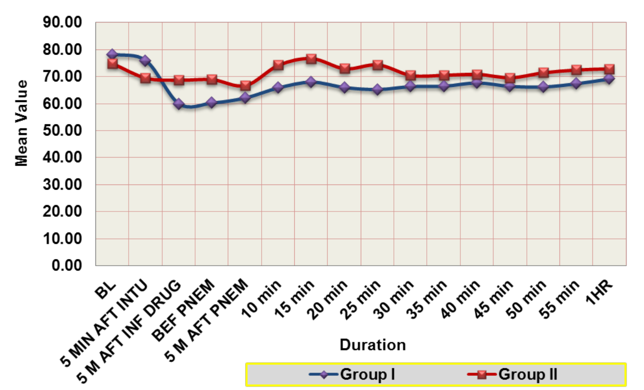

Figure 3: Comparison of DBP (mmHg) at various duration among study groups.

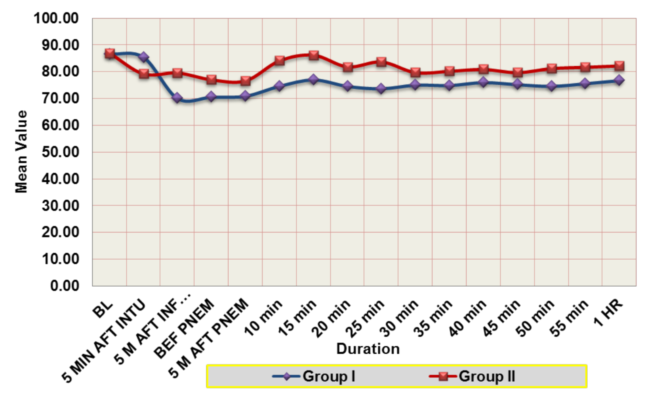

Figure 4: Comparison of MAP (mmHg) at various duration among study groups.

Diamant et al. [18] reported 35% decrease in cardiac output in dog with a raised intra-abdominal pressure of 40mmHg. Ishizaki et al. [8] Tried to evaluate the safe intra-abdominal pressure during laparoscopic surgery. They observed significant fall in cardiac output at 16 mm Hg of intra-abdominal pressure and hemodynamic alterations. So we kept intra-abdominal in our study between 12-14 mm Hg and decided to use magnesium sulphate to attenuate hemodynamic changes during laparoscopic surgeries.

Study by Joris JL et al. [3] concluded that vasopressin and catecholamines probably mediate the increase in systemic vascular resistance observed during pneumoperitoneum. Magnesium sulphate is effective in blocking the release of catecholamines from both adrenergic nerve terminals and the adrenal gland. Besides, magnesium produces vasodilatation by acting directly on blood vessels. Magnesium also attenuate vasopressin stimulated vasoconstriction. Because of the ability of magnesium sulphate to attenuate adverse hemodynamic response, we have administered 50 mg/kg magnesium sulphate as an infusion over 5 minutes. The same dosage has been used by Nand Kishore Kalra et al. [19], Deokhee Lee et al., [20] and D Jee et al. [21] in their studies.

Heart rate was low in group I throughout the study period compared to group II but was statistically significant at 10 minutes after pneumoperitoneum (80.52 ± 15.86 vs 89.87± 14.84) which was similar as reported by Suhrita Paul et al. [22], Manjushree Ray et al. [23], TO Seyhan et al., [24] Ryu JH et al., [25] and Y Nakaigawa et al. [26].

In our study systolic blood pressure was low in group I compared to group II with statistical significance at before pneumoperitoneum (97.68 ± 10.74 verses 107.16 ± 18.34 with p=0.016), 5 minutes after pneumoperitoneum (98.55 ± 11.64 verses 107.42 ± 16.03 with p=0.015), 10 minutes after pneumoperitoneum (102.45 ± 12.17 verses 114.13 ± 19.42 with p=0.006), 15 minutes after PP (105.06 ± 10.14 verses 116.35 ± 20.29 with p=0.007), 20 minutes after PP (100.71 ± 9.29 verses 115.61 ± 22.83 with p=0.001), 25 minutes after PP (99.97 ± 10.70 verses 113.00 ±17.99 with p=0.001), 30 minutes after PP (101.61 ± 9.78 verses 109.84 ± 18.79 with p=0.035), 35 minutes after PP (101.45 ± 11.31 verses 110.68 ± 18.58 with p=0.021), 40 minutes after PP (102.32 ± 9.08 verses 112.55 ± 20.86 with p=0.015), 45 minutes after PP (101.29 ± 10.86 verses 110.13 ± 18.27 with p=0.024), 50 minutes after PP (100.55 ± 13.09 verses 111.06 ± 17.72 with p=0.010), 55minutes after PP (100.71 ± 12.06 verses 111.39 ± 18.13 with p=0.008), and 60 minutes after PP (103.87 ± 11.72 verses 113.19 ± 14.86 with p=0.008).

Diastolic blood pressure was lower in group I than group II with statistical significance at 5 minutes after infusion of drug (60.00 ± 14.22 mm Hg verses 68.74 ± 14.14 mm Hg with p=0.018), before pneumoperitoneum (60.32 ± 11.86 mm Hg verses 68.94 ± 15.42 mm Hg with p=0.017), 10 minutes after pneumoperitoneum (65.94 ± 13.05 mm Hg verses 74.29 ± 14.27 mm Hg with p=0.019), 15 minutes after pneumoperitoneum (68.03 ± 9.84 mm Hg verses 76.71 ± 11.56 mm Hg with p=0.002), 20 minutes after PP (66.03 ± 9.98 mm Hg verses 72.97 ± 13.38 mm Hg with p=0.024), 25 minutes after PP (65.32 ± 10.35 mm Hg verses 74.42 ± 12.77 mm Hg with p=0.003), and 55 minutes after PP (67.45 ± 9.25 mm Hg verses 72.52 ± 10.43 mm Hg with p=0.048).

Mean arterial pressure was also lower in group I than in group II with statistical significance at 5 minutes after infusion of drug (70.16 ± 14.87 mm Hg verses 79.65 ± 14.36 mm Hg with p=0.013), 10 minutes after pneumoperitoneum (74.71 ± 12.43 mm Hg verses 84.16 ± 14.34 mm Hg with p=0.007), 15 minutes of PP (77.10 ± 9.59 mm Hg verses 86.26 ± 11.75 mm Hg with p=0.001), 20 minutes after PP (74.68 ± 10.27 mm Hg verses 81.90 ± 13.11 mm Hg with p=0.019), 25 minutes after PP (73.81 ± 10.04 mm Hg verses 83.74 ± 12.34 mm Hg with p=0.001), 50 minutes after PP (74.71 ± 10.42 mm Hg verses 81.26 ± 11.79 mm Hg with p=0.024), 55 minutes after PP (75.68 ± 10.55 mm Hg verses 81.74 ± 11.02 mm Hg with p=0.031), and 60 minutes after PP (76.84 ± 11.67mm Hg verses 82.26 ± 7.95 mm Hg with p=0.037).

D Jee et at. [28] Nand Kishore Kalra et al. [20] Y. Nakaigawa et al. [27] S. Rajan et al. [29] Deokhee Lee et al. [21] Suhrita Paul et al. [23] Manjushree Ray et al. [24] have also observed similar results.

TOF was comparable in two groups in our study. Sang-Hun Kim et al. [29] have observed results similar to our study.

Extubation time was longer in group I compared to group II. In group I extubation time was 5.77 ± 1.12 minutes verses 5.48 ± 1.23 minutes in group II but this difference has no statistical significance with p=0.346. Nand Kishore Kalra et al. [19], TO Seyhan et al. [24] have observed similar results in their studies.

We concluded from our study that use of magnesium sulphate attenuates hemodynamic stress response in laparoscopic abdominal surgeries, magnesium sulphate does not prolong neuromuscular block with single bolus dose, and under strict TOF monitoring. Magnesium sulphate may prolong extubation time but has no adverse effects on patients.

Limitations

1: We have included both abdomino-pelvic cases together as the positioning of patients is different during surgery which may affect study parameters.

2: Only ASA I score patients were included.

3: Small cohort size.

4: we have not done invasive hemodynamic monitoring to see the effects on SVR, and cardiac output.

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