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 into 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.
neuromuscular blockade was reversed with a combination of injection ondansetron 4mg, injection diclofenac sodium 75mg intravenous and nitrous Oxide were discontinued once last suture was confirmed.

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

Table 1: patient characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>p value</th>
</tr>
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<tbody>
<tr>
<td>Age (yrs)</td>
<td>37.97 ± 10.77</td>
<td>38.16 ± 8.43</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>59.19 ± 7.62</td>
<td>61.77 ± 8.28</td>
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<tr>
<td>M/F</td>
<td>3/28</td>
<td>3/28</td>
<td></td>
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Table 2: Baseline vitals.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>91.39 ± 16.74</td>
<td>89.32 ± 15.18</td>
<td>0.613</td>
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<tr>
<td>SBP</td>
<td>124.35 ± 18.89</td>
<td>125.26 ± 15.81</td>
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<tr>
<td>DBP</td>
<td>78.26 ± 22.59</td>
<td>74.87 ± 9.56</td>
<td>0.445</td>
</tr>
<tr>
<td>MAP</td>
<td>86.81 ± 9.87</td>
<td>87 ± 10.14</td>
<td>0.94</td>
</tr>
</tbody>
</table>

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.
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 113.00 ±17.99 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 versus 111.06 ± 17.72 with p=0.010), 55 minutes after PP (100.71 ± 12.06 versus 111.39 ± 18.13 with p=0.008), and 60 minutes after PP (103.87 ± 11.72 versus 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 versus 68.74 ± 14.14 mm Hg with p=0.018), before pneumoperitoneum (60.32 ± 11.86 mm Hg versus 68.94 ± 15.42 mm Hg with p=0.017), 10 minutes after pneumoperitoneum (65.94 ± 13.05 mm Hg versus 74.29 ± 14.27 mm Hg with p=0.019), 15 minutes after pneumoperitoneum (68.03 ± 9.84 mm Hg versus 76.71 ± 11.56 mm Hg with p=0.002), 20 minutes after PP (66.03 ± 9.98 mm Hg versus 72.97 ± 13.38 mm Hg with p=0.024), 25 minutes after PP (65.32 ± 10.35 mm Hg versus 74.42 ± 12.77 mm Hg with p=0.003), and 55 minutes after PP (67.45 ± 9.25 mm Hg versus 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 versus 79.65 ± 14.36 mm Hg with p=0.013), 10 minutes after pneumoperitoneum (74.71 ± 12.43 mm Hg versus 84.16 ± 14.34 mm Hg with p=0.007), 15 minutes of PP (77.10 ± 9.59 mm Hg versus 86.26 ± 11.75 mm Hg with p=0.001), 20 minutes after PP (74.68 ± 10.27 mm Hg versus 81.90 ± 13.11 mm Hg with p=0.019), 25 minutes after PP (73.81 ± 10.04 mm Hg versus 83.74 ± 12.34 mm Hg with p=0.001), 50 minutes after PP (74.71 ± 10.42 mm Hg versus 81.26 ± 11.79 mm Hg with p=0.024), 55 minutes after PP (75.68 ± 10.55 mm Hg versus 81.74 ± 11.02 mm Hg with p=0.031), and 60 minutes after PP (78.64 ± 11.67 mm Hg versus 82.26 ± 7.95 mm Hg with p=0.037).

D’ee et al. [28] and Kishore Kalra et al. [20] and Y. Nakaigawa et al. [27] and Rajan et al. [29] and Deokbee Lee et al. [21] and Subhita Paul et al. [23] and 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.

Exubation time was longer in group I compared to group II. In group I exubation time was 5.77 ± 1.12 minutes versus 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 exubation 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.


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

**References**


5. Millers Anesthesia Chapter 68—Anaesthesia for laparoscopic surgery.


pneumoperitoneum in patients undergoing laparoscopic cholecystectomy. Anaesthesia Essays and Researchs. 7: 228-231.


