Efficacy of Magnesium Sulphate to Prevent Arterial Pressure Increases During Laparoscopic Cholecystectomy

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Abstract:

Background: *Carbon dioxide pneumoperitoneum (PP) for laparoscopic surgery increases arterial pressure and systemic vascular resistance, these vasopressor responses are likely to be due to increased release of catecholamine. Magnesium is well known to inhibit catecholamine release and attenuate vasopressin stimulated vasoconstriction.*

Objectives: *This study has been undertaken with a view to find out the efficacy of magnesium sulphate to prevent arterial pressure increases associated with carbon dioxide pneumoperitoneum (PP) in patients undergoing laparoscopic cholecystectomy.*

Methods: *Sixty patients, of either sex, 18 60 years of age, undergoing elective laparoscopic cholecystectomy were randomly allocated in one of the two group's containing 30 patients each. Magnesium Sulphate Group "M" received magnesium sulphate 30 mg/kg intravenously as a bolus beforecarbon dioxide pneumoperitoneum (PP).A control Group "C" received same volume of normal salinebefore carbon dioxide pneumoperitoneum (PP).*

Results: *Mean arterial pressure was significantly less throughout the period ofpneumoperitoneum in patients of Group M. Intravenous labetalol was required in 46.66% (14out of 30) of the patients in group C to control intraoperative hypertension and it was clinicallysignificant in comparison to group M.*

Conclusion: *Our study concluded that intravenous Magnesium Sulphate administered before carbon dioxide pneumoperitoneum (PP) attenuates arterial pressure increases during laparoscopic cholecystectomy effectively and provides better hemodynamic stability.*

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

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Introduction:

Laparoscopic cholecystectomy is very popular now a days, carbon dioxide is commonly used to create pneumoperitoneum (PP) in laparoscopic cholecystectomy.[1,2] Both carbon dioxide and pneumoperitoneum affects homeostasis and leads toalterations in cardiovascular physiology, pulmonary physiology and stress responses.[1,2,3,4,5] Cardiovascular changes include increase in mean arterial pressure (MAP) with no significant change in heart rate,[6,7,8] decrease in cardiac output and increase in systemic vascular resistance (SVR). These vasopressor stress responses are consequent to hypercarbia induced release of catecholamine,[9,10,11] vasopressin, or both.[6,12,13] These circulatory responses to PP is usually attenuated by opioids,[14] vasodilators,[15] beta blocking agents[16] and alpha 2adrenergic agonists.[17] Magnesium has the ability to block the release of catecholamine from both the adrenal gland and the adrenergic nerve terminals.[18]

Magnesium also produces vasodilation by acting directly on blood vessels[19] and in high doses magnesium attenuates vasopressin mediated vasoconstriction.[20]

In this study, we investigated the efficacy of magnesium sulphate to prevent arterial pressure increases in patients undergoing laparoscopic cholecystectomy.

Materials and methods:

This prospective clinical study was conducted at department of Anaesthesia,CMH Dhaka from January 2017 to June 2017. After approval from departmental review board and obtaining patient's written informed consent, 60 patients of American Society of Anesthesiologists (ASA) physical status I & II aged 18 65 years undergoing elective laparoscopic cholecystectomy with CO_2 pneumoperitoneum, were enrolled in this study. Patients with a known allergy to magnesium sulphate, any degree of heart block, hypertension, diabetes mellitus, cardiovascular or kidney disease, acute cholecystitis were excluded from the study. Patients are assigned to one of the two groups, each containing 30 patients, Group M (Magnesium Sulphate Group) and Group C (Control Group). All the patients received tab. diazepam 10 mg orally onthe night before surgery. On arrival to operation theatre ECG, pulse oximetry, non-invasive bloodpressure (NIBP) monitoring were started and baseline vital parameters like heart rate, mean arterial pressure (MAP), and arterial oxygen saturation (SPO_2) were recorded. An intravenous linewas started. Patients were induced with pethidine 1.5 mg/kg andthiopentone sodium 5 mg/kg. Endotracheal intubation was facilitated bymuscle relaxant vacuronium 0.1 mg/kg. Group M patientsreceived magnesium sulphate 30 mg/kg intravenously as abolus and group C received same volume of normal saline as a bolus intravenously immediately before pneumoperitonium. Anaesthesia was maintained with 33% O_2 in N_2O, 0.5% halothane and vacuronium. CO_2 was insufflated intothe peritoneal cavity to create PP. Intra abdominalpressure (IAP) was maintained to 14 mmHg throughout the laparoscopic procedure. All the patients' were positioned in a head up tilt for about 15°. During hemodynamic fluctuations, the following medical interventions were taken: for hypotension (MAP < 60 mmHg) increased rate of infusion of i.v fluid and/or i.v bolus dose ofinj. Ephedrine 5 mg and for hypertension (MAP > 110 mmHg) i.v bolus dose of inj. Labetalol 5 mg.At the end of the operation, ondansetron 4 mg i.v wasadministered for prophylaxis against nausea and vomiting. Residual neuromuscular block was reversed by appropriate doseof neostigmine and atropine and tracheal extubation was performed. Heart rate and MAP wererecorded at the following points of time: (1) Baseline (2) before PP (3) 15 min, 30 min, 45 min and 60 minafter PP (4) after release of PP and (5) after extubation. Patients were observed for any adverse events likebradycardia, hypotension, and hypertension during postoperative period.

All the variables were expressed as mean ± SD; student t-test and chi-square test were done as the test of significance. The statistical analysis was done by using Graph pad software. P-value < 0.05 was considered as statistically significant.

Results:

Patient's demographics data were shown in Table-I. Both the groups were comparable with respect to age, sex, bodyweight and duration of surgery. No statistical significant differences were found between the two study groups.

Table- I *Patient's characteristics and duration of surgery*

	Group M (n=30)	Group C (n=30)	*P value*
Age (years)	42.5±9.77	44.66±7.88	0.3498
Sex (M/F)	12/18	11/19	
Weight (kg)	60.55±9.7	63.30±5.4	0.1801
Duration of surgery (min)	70.7±4.8	72.4±5.6	0.2118

Values were expressed as Mean ± SD, values are regarded significant if P-value < 0.05. There was no significant changes between the groups.

Changes in heart rate were shown in Table-II. No statistical significant differences were found between the two study groups.

Table-II *Changes in heart rate*

	Group M (n=30)	Group C (n=30)	P value
Preoperative	73.4±7.3	75.3±5.2	0.2504
Before PP	78.8±9.5	79.2±7.9	0.8599
15 min after PP	82.4±9.5	84.88±12.7	0.3953
30 min after PP	81.6±9.7	86.4±14.3	0.1336
45min after PP	82.3±7.7	85.7±11.9	0.1941
60min after PP	81.9±12.3	84.8±12.7	0.3727
After release of PP	79.7±13.7	82.4±13.9	0.4517
After extubation	90.5±8.7	92.5±8.6	0.3742

Values were expressed as Mean ± SD, values are regarded significant if P-value < 0.05

There was no significant change in heart rate between the groups.

Changes in mean arterial pressure (MAP) were shown in Table-III. There wasno significant difference in the preoperative mean arterial pressure (MAP) values and before pneumo-peritoneum (PP) values between two study groups. MAP values in Group-M were significantly lower (*P* < 0.05) throughout the PP, after the release of PP and after extubation compared to Group-C.

Table-III

Changes in mean arterial pressure

	Group M (n=30)	Group C (n=30)	*P* value
Preoperative	91.5±7.4	92.3±8.7	0.7026
Before PP	95.6±8.5	97.6±7.9	0.3491
15 min after PP	97.8±9.2	107.7±11.9	0.0006
30 min after PP	98.4±8.5	108.9±12.4	0.0003
45 min after PP	96.5±9.9	106.6±8.87	0.0001
60 min after PP	97.2±5.5	107.5±7.45	0.0001
After release of PP	93.2±6.8	102.4±11.7	0.0004
After extubation	95.5±8.7	105.8±9.8	0.0001

Values were expressed as Mean ± SD, values are regarded significant if P-value < 0.05. MAP vary significantly from 15 min after PP to extubation between the groups.

No patient suffered from bradycardia or hypotension in our study. Hypertension occurred in 14 patients of group C, whereas no patient of group M suffered from hypertension. (Table-IV) The difference was statistically significant (*P* <0.05).

Table-IV

Distribution of patients according to adverse effects

Adverse effects	Group M (n=30)	Group C (n=30)	Percentage %	P value
Bradycardia	0	0	0.0	-
Hypotension	2	0	6.67	0.1502
Hypertension	0	14	46.67	0.0001

Values are regarded as significant if P-value < 0.05.

Discussion:

In this study, we studied the effects of magnesium sulphateon hemodynamic in patients undergoing laparoscopic cholecystectomy. During laparoscopic surgery, CO_2 is routinely used tocreate PP. Elevated IAP induced by PP and CO_2 itself produce some adverse effects on the cardiovascularand respiratory system.[1,2,3,4,5] Immediately after PP, plasma level ofcatecholamine's and vasopressin is increased.[9,10,12,13] Increased catecholamine level activates the renin angiotensinaldosterone system (RAAS) leading to some characteristic hemodynamic alterations[3,4,9,10] which include decreased cardiac output, elevated arterial pressure, and increased systemic pulmonary vascular resistance. Vasopressin alsocontributes to elevation of arterial pressure and systemic vascular resistance.[12,13] As already mentioned in introduction, various pharmacological agents have been used to attenuate these adverse hemodynamic effects of PP.[14,15,16,17] Magnesium is effective in blocking therelease of catecholamine's from both adrenergic nerve terminals and the adrenal gland.[18] Besides, magnesium produces vasodilatation by acting directly on bloodvessels.[19] In addition to catecholamine's, vasopressin is a major contributor to the hemodynamic changes induced by PP.[12,13] Magnesium attenuates vasopressin stimulated vasoconstriction.[20] Laparoscopic cholecystectomy is performed in reverse trendelenburg position, this particular position causes diminished venous return which ultimately leads to further decrease in cardiac output.[21]

In a study, James *etal*.[22] observed that i.v magnesium sulphate was able to attenuate the adverse hemodynamic response of endotracheal intubation. Because of the ability of magnesium sulphate to attenuate adverse hemodynamic response, we have administered 30 mg/kg magnesium sulphate as a bolus before PP and observed its effect on hemodynamic response to PP. Telci and etal.[23] used i.v Magnesium sulphate in a dose of 30 mg/kg bolus before induction and 10 mg/kg/h continuous i.v infusion ina study to observe the efficacy of magnesium sulphate to decrease anaestheticrequirement.[23] We did not administer any infusion of magnesium intraoperatively. In our study we observed that i.v magnesium sulphate in a bolusdose of 30 mg/kg before PP was able to attenuate the adverse hemodynamic response. Diamant*eta*l.[24] reported 35% decrease in cardiac output in dog with a raised IAP of 40 mmHg. Ishizakietal.[25] tried to evaluate the safe IAP during laparoscopic surgery. They observed significant fall in cardiac output at 16 mmHg of IAP and hemodynamic alterations were much less at 14 mm Hg of IAP. So in our study, we kept IAP 14 mm Hg. In spite of maintaining normocapnia and keeping IAP 14mm Hg, there was significant rise of MAP in patients of group C. However, in group M, hemodynamic responses to PP were effectively blunted and MAP remained at a significantly lower level compared to group C. Thus i.v magnesium sulphate effectively attenuated adverse hemodynamic response.Regarding the incidence of adverse effects, no patient ofeither group suffered from bradycardia in our study. Hypertension occurred in 14 patients of group C for which they had to be treated with Inj. labetalol whereas no patient of group M suffered from hypertension.

To conclude, administration of magnesium sulphate before commencement of Carbon dioxide pneumoperitoneum effectively prevent arterial pressure increases during laparoscopic cholecystectomy and thereby provides perioperative hemodynamic stability.

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