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Original Research Article

To Compare Different Doses of Magnesium Sulphate on Hemodynamic Changes in Patients Undergoing Laparoscopic Surgery

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Abstract

Aim: The aim of the present study was to compare different doses of magnesium sulphate on hemodynamic changes in patients undergoing laparoscopic surgery.

Methods: The study was conducted at Indira Gandhi Institute of Medical Sciences, Patna, India for the period of one year after obtaining ethical clearance from the Institutional Ethics Committee, IGIMS, Patna, India. Total 78 patients were randomly divided into 3 groups. Written informed consent was obtained from all the patients before enrolling them for the study.

Results: There was no significant association between gender and group (p=0.524). There was insignificant association between ASA grade and group (p=0.502). There were insignificant changes in the heart rate among all three groups at all time intervals (p value>0.05). There were no significant differences in SBP among the three groups till 5 minutes after pneumoperitoneum, but after that time SBP and DBP was significantly less in group MB compared to group MA and group C till extubation. VAS at 5 minutes and at 20 minutes post extubation was significantly less in group MB compared to group MA and also with group C (p value< 0.05). Fentanyl requirement was less in group MB (only 3 patients among 26 patients) than in group MA (11 patients among 26 patients) and group C (20 patients among total 26 patients). This difference was statistically significant. (p value < 0.05). Extubation time was less in group MB (with a mean of 7.73) compared to group MA (Mean 8.31) and group C (mean 8.88) but the difference in extubation time between the three groups was insignificant (p value> 0.05).

Conclusion: The present study concluded that magnesium sulphate attenuates the increase in blood pressure during pneumoperitoneum thus provides intra operative hemodynamic stability during laparoscopic surgery. Our study demonstrated that intravenous magnesium sulphate in a dose of 50mg/kg body weight given before creation of pneumoperitoneum attenuates the hemodynamic alteration during laparoscopic surgery and also reduces the post -operative pain. There were no complications noted during our study.

Keywords: laparoscopic surgery, hemodynamic changes, magnesium sulphate, Pneumoperitoneum.

Introduction

Although laparoscopic abdominal surgery has significant advantages, such as less trauma and faster recovery, the hemodynamic changes induced by pneumoperitoneum and the reverse Trendelenburg position are still challenges for anesthesia management during the surgery. The hemodynamic changes are characterized by abrupt elevations of arterial pressure and systemic vascular resistance. Besides the increase of intra-abdominal pressure, the increased levels of vasopressin, catecholamines, renin, and angiotensin are likely to be the reasons for these hemodynamic changes.[1,2] These severe hemodynamic changes may have a significant impact on the perioperative status of the patient, especially in elderly patients with existing cardiovascular diseases.

Therefore, it is crucial to use safe and effective drugs for maintaining hemodynamic stability during abdominal laparoscopy in such patients. Magnesium sulfate is a well-known safe antihypertensive drug, which can be used during the perioperative period.[3] It can effectively attenuate the adverse hemodynamics fluctuations during laparoscopy, prevent the adverse cardiovascular events during laryngoscopy and tracheal intubation[4,5], reduce the stress response, and strengthen the postoperative analgesia.[6] First laparoscopic cholecystectomy was performed by Phillipe Mouret and soon the procedure got wide-spread acceptance, as being less

traumatic.[7] The complications associated of pneumoperitoneum (PP) including neurohumoral stress response, however, continued to pose a challenge.[8]

The hemodynamic alterations caused by pneumoperitoneum created in laparoscopic surgery and the posture of the patient during surgery present new complications for anaesthetic management during the surgery.[9] The hemodynamic changes are characterized by a sudden rise in systemic vascular resistance and arterial pressure. These vasopressor responses are presumably brought on by factors such as the increased release of catecholamine, vasopressin, renin, and angiotensin as well as an increase in intra-abdominal pressure.[10] Magnesium is the fourth most abundant cation in the human body and participates in various physiological and metabolic functions in many capacities to maintain homeostasis of the human body. One of the functions of magnesium is to act as a natural antagonist of calcium because it is a non - competitive inhibitor of calcium channels with inositol triphosphate.[11] Calcium is also critical in many physiological functions, but excess calcium can prove detrimental to patients under anesthesia and patients with unfavourable cardiopulmonary function. As magnesium antagonizes calcium, it can serve as a protectant during the release of norepinephrine to prevent the increase in HR and vasoconstriction in the patient which leads to increased afterload and workload on the left heart. In addition to this magnesium sulfate can reduce stress and post-operative pain.[12]

The aim of the present study was to compare different doses of magnesium sulphate on hemodynamic changes in patients undergoing laparoscopic surgery.

Materials and Methods

The study was conducted at Indira Gandhi Institute of Medical Sciences, Patna, India for the period of one year after obtaining ethical clearance from the Institutional Ethics Committee, IGIMS, Patna, India and registering the trial with clinical trial registry India (www.ctri.nic.in) vide registration number CTRI/2021/11/037788. 78 patients were randomly divided into 3 groups. Written informed consent was obtained from all the patients before enrolling them for the study.

Inclusion criteria

- ASA physical status 1 and 2
- Patients between 30 years – 65 years of age of either sex
- Patients able to comprehend to participate.
- Patients undergoing laparoscopic surgery with carbon dioxide pneumoperitoneum.

Exclusion criteria

- Patients refusal to participate
- Contraindication to use of magnesium sulphate
- Patients on concomitant antihypertensive
- Patient with unstable BP (HTN or hypotension), cardiac dysfunction (NYHA grade 3 and 4), morbid obesity, and severe renal, hepatic or endocrine dysfunction

Methodology

Patient, premedicated with intravenous ranitidine 0.25 mg/kg, metoclopramide 0.15 mg/kg and glycopyrrolate 0.01 mg/kg in preoperative room. On arrival in the operation theatre monitors were attached (HR, NIBP, oxygen saturation, ECG, EtCO2) and baseline vital parameters like heart rate, systolic and diastolic blood pressure and oxygen saturation was recorded. Injection fentanyl 2µg/kg body weight was given for analgesia.

Anaesthesia was induced with intravenous propofol 2mg/kg and vecuronium bromide 0.1mg/kg was used to facilitate tracheal intubation. Anaesthesia was maintained by oxygen, nitrous oxide (33:66), isoflurane and intermittent intravenous bolus injection of vecuronium (0.02 mg/kg).

Intermittent positive pressure ventilation (IPPV) was delivered with tidal volume and respiratory rate adjusted to maintain end tidal carbon dioxide between 35-45 mmHg.

Syringes were prefilled with test drug and were given to the anaesthesiologist conducting the case. The drug was given to the patient immediately after induction and before initiation of pneumoperitoneum. The intra-abdominal pressure was maintained at 12 - 14 mmHg after creating pneumoperitoneum. The central line and intra-arterial cannulation were performed if required in that surgery. After the completion of surgery, residual neuromuscular block was reversed with neostigmine and glycopyrrolate, then trachea was extubated

	C (control group)	MA	MB
Loading dose	100ml of 0.9%NS	30 mg/kg of body weight in 100ml of NS given over 10 minutes.	50 mg/kg of body weight in 100ml of NS given over 10 minutes.

Outcome parameters

Primary outcome: It included the difference in HR, SBP, DBP, MAP, between different groups.

Secondary outcome: It included the difference in extubation time and incidence of postoperative pain, shivering and any other side effect in different group.

Study variables: Magnesium sulphate doses.

Statistical methods

Data obtained was saved in study performa and then the same was entered in SPSS software program for Windows, version 28.0(SPSS, Chicago, Illinois) for analysis. Continuous variables are presented as mean+-SD and categorical variables are presented as absolute numbers and percentages. Data were checked for normality before statistical analysis. One-way analysis of variance (ANOVA) was used to evaluate the significance of the differences in preoperative and intraoperative variables among the patients. If the F value was significant and variance was homogenous, Tukey's multiple comparison test was used to assess the differences between the individual groups; otherwise, Tamhane's T2 test was used. For all statistical tests, p value<0.05 was taken to indicate a significant difference

Results

Table 1: Gender distribution of cases

Sex	Group C	Group MA	Group MB	p value
	Frequency (%)	Frequency (%)	Frequency (%)	
F	23 (88.5%)	20 (76.9%)	22 (84.63%)	0.524
M	3 (11.5%)	6 (23.1%)	4 (15.4%)	
Total	26 (100%)	26 (100%)	26 (100%)	
ASA Grade				
1	13 (50.0%)	16 (61.5%)	17 (65.4%)	0.502
2	13 (50.0%)	10 (38.5%)	9 (34.6%)	
Total	26 (100%)	26 (100%)	26 (100%)	

There was no significant association between gender and group (p=0.524). There was insignificant association between ASA grade and group (p=0.502).

Table 2: Changes in heart rate at various time points

Heart rate (BPM)	Group C	Group MA	Group MB	p value	Group C vs Group MA	Group C vs Group MB	Group MA vs Group MB
	Mean ± SD	Mean ± SD	Mean ± SD				
Baseline	76.92 ± 5.24	76.23 ± 4.89	78.65 ± 1.79	0.115	0.828	0.314	0.108
T1	78.15 ± 4.51	77.73 ± 4.3	79.15 ± 2.63	0.428	0.924	0.644	0.413
T2	76.88 ± 5.05	77.38 ± 4.34	78.58 ± 1.9	0.298	0.894	0.285	0.532
T3	77.35 ± 4.9	77 ± 4.32	78.46 ± 1.77	0.375	0.945	0.561	0.373
T4	78.88 ± 4.57	79.15 ± 3.68	78.65 ± 1.65	0.877	0.959	0.970	0.866
T5	77.54 ± 4.75	78.35 ± 3.86	78.46 ± 1.53	0.611	0.704	0.633	0.993
T6	78.15 ± 4.81	77.58 ± 4.09	79.15 ± 1.62	0.316	0.845	0.605	0.291
T7	76 ± 4.92	76.85 ± 4.08	77.04 ± 1.4	0.575	0.699	0.584	0.982

There were insignificant changes in the heart rate among all three groups at all time intervals (p value>0.05).

Table 3: Comparison of Systolic Blood Pressure at various time points

SBP	Group C	Group MA	Group MB	p value	Group C v/s Group MA	Group C v/s Group MB	Group MA v/s Group MB
	Mean ± SD	Mean ± SD	Mean ± SD				
Baseline	**124.88 ± 9.09**	**125 ± 9.44**	**123.88 ± 9.14**	**0.892**	**0.999**	**0.919**	**0.901**
T1	**110.65 ± 7.39**	**111.81 ± 7.69**	**112.96 ± 7.69**	**0.551**	**0.848**	**0.519**	**0.848**
T2	**123.65 ± 8.54**	**124.5 ± 8.72**	**121.35 ± 7.068**	**0.373**	**0.848**	**0.929**	**0.364**
T3	**126.73 ± 8.07**	**128.65 ± 8.26**	**127.96 ± 8.47**	**0.698**	**0.680**	**0.853**	**0.951**
T4	**140.50 ± 7.90**	**135.27 ± 7.58**	**129.88 ± 7.05**	<0.001	0.038	<0.001	0.031
T5	**138.27 ± 7.76**	**132.73 ± 7.47**	**128.54 ± 6.98**	<0.001	0.023	<0.001	0.110
T6	**133.65 ± 8.35**	**128.15 ± 8.16**	**126.58 ± 6.89**	0.004	0.035	0.005	0.749
T7	**124.96 ± 8.49**	**126.62 ± 8.28**	**126.42 ± 7.53**	**0.525**	**0.743**	**0.793**	**0.996**

There were no significant differences in SBP among the three groups till 5 minutes after pneumoperitoneum, but after that time SBP was significantly less in group MB compared to group MA and group C till extubation.

Table 4: Comparison of DBP among three groups at various time points

DBP	Group C	Group MA	Group MB	p value	Group C v/s Group MA	Group C v/s Group MB	Group MA v/s Group MB
	Mean ± SD	Mean ± SD	Mean ± SD				
Baseline	74.77 ± 6.11	75.38 ± 6.08	76.04 ± 5.27	0.736	0.923	0.714	0.914
T1	76.69 ± 6.03	77.31 ± 6	77.73 ± 5.17	0.807	0.921	0.792	0.792
T2	83.04 ± 4.86	82.81 ± 4.87	81.54 ± 4.85	0.491	0.984	0.509	0.616
T3	90.08 ± 3.8	89.54 ± 3.82	88.58 ± 3.28	0.328	0.855	0.304	0.609
T4	96.12 ± 3.85	91.31 ± 5.66	85.62 ± 2.8	<0.001	<0.001	<0.001	<0.001
T5	92.12 ± 3.85	90 ± 5.03	85.12 ± 2.96	0.001	0.001	<0.001	<0.001
T6	86.31 ± 4.04	83.73 ± 3.79	82.69 ± 3.00	0.002	0.033	0.002	0.561
T7	84.27 ± 4.3	82.46 ± 4.36	81.85 ± 3.15	0.080	0.235	0.078	0.842

There were no significant differences in DBP among the three groups till 5 minutes after pneumoperitoneum, but after that time DBP was significantly less in group MB compared to group MA and group C till extubation.

Table 5: Comparison of VAS in post operative period

	Group 1	Group 2	Group 3	p value	Group C vs Group MA	Group C vs Group MB	Group MA vs Group MB
	Mean ± SD	Mean ± SD	Mean ± SD				
VAS(5min)	4.42 ± 1.03	4.00 ± 9.39	3.54 ± 0.99	<0.001	0.294	<0.001	0.021
VAS (20min)	2.54 ± 1.07	2.27 ± 0.83	1.65 ± 0.98	<0.001	0.574	<0.001	0.004

VAS at 5 minutes and at 20 minutes post extubation was significantly less in group MB compared to group MA and also with group C (p value< 0.05).

Table 6: Fentanyl requirement in postoperative period

Fentanyl	Group C	Group MA	Group MB	p value	Group C Vs Group MA	Group C Vs Group MB	Group MA Vs Group MB
	Frequency (%)	Frequency (%)	Frequency (%)				
NO	6 (23.1%)	15 (57.7%)	23 (88.5%)	<0.001	0.024	<0.001	0.027
YES	20 (76.9%)	11 (42.3%)	3 (11.5%)				
Total	26 (100%)	26 (100%)	26 (100%)				

Fentanyl requirement was less in group MB (only 3 patients among 26 patients) than in group MA (11 patients among 26 patients) and group C (20 patients among total 26 patients). This difference was statistically significant. (p value < 0.05).

Table 7: Comparison of extubation time

	Group C	Group MA	Group MB	p value	Group C v/s Group MA	Group C v/s Group MB	Group MA v/s Group MB
	Mean ± SD	Mean ± SD	Mean ± SD				
Ex. Time (min)	8.88 ± 2.61	8.31 ± 2.72	7.73 ± 1.87	0.238	0.670	0.208	0.670

Extubation time was less in group MB (with a mean of 7.73) compared to group MA (Mean 8.31) and group C (mean 8.88) but the difference in extubation time between the three groups was insignificant (p value> 0.05).

Discussion

Laparoscopic surgery is commonly used now-a-day to perform a wide range of surgical procedures. In comparison to conventional open surgery, laparoscopic surgery offers many advantages to patients including quicker recovery, shorter hospital stay, early return to regular activities, better cosmetic results, and less post-operative pain.[13] Magnesium sulphate is believed to improve cardiac output by reducing peripheral resistance but there is no available direct hemodynamic monitoring method to prove this effect. Action of MgSO4 is multimodal; It inhibits the release of catecholamine's from the adrenergic nerve terminals and adrenal glands,[14,15] therefore, it is being used in managing cases of pheochromocytoma, pre-eclampsia, eclampsia and other conditions. It produces vasodilatation by acting directly on the blood vessels and thus, can attenuate the vasopressin mediated vasoconstriction. It is also used to attenuate the pressor response associated with tracheal intubation. It has antinociceptive effects due to the regulation of calcium influx into the cell and that is the natural physiological antagonism of the NMDA receptor.

In this study we found that there was significantly less incidence of hemodynamic alteration in group MB (50 mg/kg body weight of magnesium sulphate) than group MA (30 mg/kg body weight of magnesium sulphate) and the control group. The result showed that MAP of group C was significantly higher than group MA than group MB at time interval T4, T5, T6. However no significant change in heart rate was present. Increase in blood pressure occurred in 2 patients of group C for which we gave injection labetalol.

Not many studies have been done regarding the use of magnesium sulphate only for attenuating hemodynamic stress response to pneumoperitoneum and also comparing two different doses of MgSO4 in same study. Bolus drug dose and result of our study is quite similar with the result of a prospective randomized controlled study by Tan W et al[16] which recommended that administering IV MgSO4 50mg/kg before PP attenuates the arterial pressure increase better than magnesium sulphate at 30mg/kg during laparoscopic surgery. They also concluded that intraoperative requirement of opioid was less with the use of magnesium sulphate. In contrast to our study, many studies were conducted using single dose of magnesium sulphate and comparing it with normal saline.

Similar result was also found by Kalra NK et al[17] who concluded that magnesium sulphate 50mg/kg produces hemodynamic stability comparable to clonidine 1 µg/kg and recommended that administration of magnesium sulphate or clonidine attenuates the hemodynamic response to pneumoperitoneum. However, they recommended that higher doses of clonidine (1.5 µg/kg) produce better hemodynamic stability in laparoscopic surgery than magnesium sulphate and clonidine of dose 1µg/kg. However, we have not done a comparative study using clonidine. Similarly, Maya G et al[18] and Jee D et al[19] also concluded from their study that intravenous magnesium sulphate at a dose of 50 mg/kg given prior to creation of PP attenuates the hemodynamic response to PP.

Magnesium sulphate has been found to reduce the plasma catecholamine and vasopressin levels, thus contributing to its blunting effect on sympathoadrenal hemodynamic stress response.[20] These effects of magnesium are noted at serum concentration of 2-4 mmol/L. Although in our study serum magnesium level was not measured, previous studies shows that a dose of 50mg/kg achieve this plasma level. Magnesium also has vasodilator action, thus reduces blood pressure. In pneumoperitoneum vasopressin concentration increases because of increased compression of abdominal capacitance vessels followed by a decrease in venous return to heart. Magnesium due to its vasodilator property decrease release of vasopressin.

Conclusion

The present study concluded that magnesium sulphate attenuates the increase in blood pressure during pneumoperitoneum thus provides intra operative hemodynamic stability during laparoscopic surgery. Our study demonstrated that intravenous magnesium sulphate in a dose of 50mg/kg body weight given before creation of pneumoperitoneum attenuates the hemodynamic alteration during laparoscopic surgery and also reduces the post -operative pain. There were no complications noted during our study.

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