RESEARCH PAPER

A Comparative Study of Clonidine and Magnesium Sulphate on Intraoperative Hemodynamics in Patients Undergoing Laparoscopic Abdominal Surgery

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ABSTRACT

Background:

Laparoscopic abdominal surgeries are associated with significant hemodynamic changes due to pneumoperitoneum, leading to increased sympathetic activity, tachycardia, and hypertension. Pharmacological agents such as clonidine and magnesium sulphate are used to attenuate these responses; however, their comparative efficacy remains an area of clinical interest.

Aim:

To compare the effect of clonidine and magnesium sulphate on intraoperative hemodynamic parameters in patients undergoing laparoscopic abdominal surgery.

Methods:

This prospective, comparative study was conducted on 78 patients undergoing elective laparoscopic abdominal surgeries. Patients were randomly allocated into two groups: Group A (n=39) received clonidine, and Group B (n=39) received magnesium sulphate. Hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were recorded at baseline and at 5, 10, 20, 30, 40, 50, and 60 minutes intraoperatively. Statistical analysis was performed using parametric tests, and $p < 0.05$ was considered statistically significant.

Results:

Baseline demographic characteristics were comparable between the groups. The mean heart rate in the clonidine group decreased from 82.1 ± 6.5 bpm at baseline to 74.8 ± 5.4 bpm at 30 minutes, whereas in the magnesium sulphate group it increased from 83.4 ± 7.1 bpm to 89.1 ± 8.5 bpm at the same time interval ($p < 0.001$). Similarly, systolic blood pressure in the clonidine group decreased from 124 ± 8.2 mmHg to 113 ± 6.5 mmHg, while in the magnesium sulphate group it remained higher (125 ± 7.9 mmHg to 121 ± 8.0 mmHg) ($p < 0.01$). Mean arterial pressure was also significantly lower in the clonidine group (92 ± 6.1 mmHg to 84 ± 5.2 mmHg) compared to the magnesium sulphate group (93 ± 6.3 mmHg to 94 ± 6.7 mmHg) ($p < 0.001$). The incidence of

adverse effects was comparable, with hypotension observed in 10.3% vs 15.4% and bradycardia in 12.8% vs 5.1% of patients in clonidine and magnesium sulphate groups respectively (p = 0.65).

Conclusion:

Clonidine provides superior attenuation of intraoperative hemodynamic responses compared to magnesium sulphate in patients undergoing laparoscopic abdominal surgery. It offers better control of heart rate and blood pressure with a comparable safety profile, making it a more effective agent for maintaining intraoperative hemodynamic stability.

Keywords: Clonidine, Magnesium sulphate, Laparoscopic surgery, Hemodynamic stability, Pneumoperitoneum, Mean arterial pressure

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INTRODUCTION

Minimally invasive surgery, especially laparoscopic procedures, has revolutionized modern surgical practice with advantages such as decreased postoperative pain, minimal tissue trauma, shorter hospital stay, and faster recovery compared to open surgery (1,2). Despite these advantages, laparoscopic surgery is associated with significant physiologic changes, primarily due to the creation of pneumoperitoneum.

Insufflation of carbon dioxide (CO2) causes an increase in intra-abdominal pressure, decreased venous return, decreased cardiac output and increased systemic vascular resistance (3,4). Absorption of CO 2 also causes hypercarbia and stimulation of sympathetic activity, which leads to tachycardia, hypertension, and increased catecholamine levels (5,6). These changes may result in hemodynamic instability intraoperatively especially in patients with compromised cardiovascular status (7). Pneumoperitoneum also affects respiratory mechanics by decreasing lung compliance and functional residual capacity, requiring meticulous anesthetic management (8).

Pharmacological agents are commonly given to attenuate these hemodynamic responses. Clonidine, an α2-adrenergic agonist, decreases sympathetic outflow and maintains stable hemodynamics by lowering heart rate and blood pressure (9,10). Magnesium sulphate is a calcium channel antagonist that reduces stress response during surgery by inhibiting the release of catecholamine and causing vasodilation (11,12).

Both agents have been demonstrated in previous studies to be effective in maintaining intraoperative stability. These drugs have significantly attenuated hemodynamic responses (2,13) by Mohamed Ali et al. (2022) and Tan et al. (2019). However, the evidence on their relative superiority remains inconclusive (14).

Thus the present study was undertaken to compare the effect of clonidine and magnesium sulphate on intraoperative haemodynamic parameters in patients undergoing laparoscopic abdominal surgery.

MATERIAL AND METHODS

The present prospective randomized double blind parallel group comparative study was conducted in Department of Anaesthesiology, National Institute of Medical Sciences (NIMS) & Research Hospital, Jaipur for a period of 6 months. Methods: Written informed consent was obtained from 78 adult patients aged 18-65 years with American Society of Anesthesiologists (ASA) physical status I-II scheduled for elective laparoscopic abdominal surgery under general anesthesia.

Patients were randomized in two groups (n=39 each) according to a computer-generated sequence with sealed envelope concealment. Group A received intravenous clonidine (1 µg/kg diluted in 100 ml normal saline) and Group B received intravenous magnesium sulphate (40 mg/kg diluted in 100 ml normal saline) infused over 10 minutes before induction. The anesthesiologist and observer were unaware of the group allocation.

All patients received standardized general anesthesia with glycopyrrolate, midazolam, fentanyl, propofol, atracurium, and isoflurane with controlled ventilation. Pneumoperitoneum with carbon dioxide was maintained at an intraabdominal pressure of 12 to 14 mm Hg.

Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were measured at baseline, during medication administration, and at 5, 10, 20, 30, 40, 50, and 60 minutes throughout surgery. Bradycardia and hypotension were identified and treated in accordance with usual procedure.

SPSS version 27 was used to analyze the data. The mean ± standard deviation was used to express continuous variables. Statistical significance was defined as a p-value of less than 0.05.

RESULT

There were 78 patients in all, split equally across two groups of 39. The groups' baseline demographic traits were similar. The mean body weight was 65.9 ± 8.5 kg and 66.4 ± 8.1 kg, respectively, and the mean age was 42.3 ± 10.8 years in the clonidine group and 41.7 ± 11.2 years in the magnesium sulphate group ($p = 0.78$). ASA physical status and gender distribution were likewise similar ($p > 0.05$).

The magnesium sulphate group's heart rate increased from 83.4 ± 7.1 bpm to 89.1 ± 8.5 bpm ($p < 0.001$), while the clonidine group's heart rate significantly decreased from 82.1 ± 6.5 bpm at baseline to 74.8 ± 5.4 bpm at 30 minutes. Similarly, the clonidine group's systolic blood pressure dropped from 124 ± 8.2 mmHg to 113 ± 6.5 mmHg, whereas the magnesium sulphate group's blood pressure remained higher (125 ± 7.9 mmHg to 121 ± 8.0 mmHg) ($p < 0.01$).

Additionally, the clonidine group's mean arterial pressure was substantially lower (92 ± 6.1 mmHg to 84 ± 5.2 mmHg) than the magnesium sulphate group's (93 ± 6.3 mmHg to 94 ± 6.7 mmHg) ($p < 0.001$). From five minutes on, there were noticeable disparities between the groups, and these differences continued throughout the intraoperative period.

The incidence of side effects was similar between the groups, with bradycardia occurring in 12.8% vs. 5.1% of patients in the magnesium sulphate group and hypotension occurring in 10.3% vs. 15.4% of patients in the clonidine group ($p = 0.65$).

Table 1: Comparison of Baseline Demographic Characteristics Between Study Groups

Variable	Group A (Clonidine, n=39)	Group B ($MgSO_4$, n=39)
Age (years)	42.3 ± 10.8	41.7 ± 11.2
Weight (kg)	65.9 ± 8.5	66.4 ± 8.1

Table 2: Comparison of Gender Distribution Between Study Groups

Gender	Group A (Clonidine, n=39)	Group B ($MgSO_4$, n=39)
Male	22 (56.4%)	21 (53.8%)
Female	17 (43.6%)	18 (46.2%)
Total	39 (100%)	39 (100%)

Table 3: Comparison of ASA Physical Status Distribution Between Study Groups

ASA Grade	Group A (Clonidine, n=39)	Group B ($MgSO_4$, n=39)
I	24 (61.5%)	23 (59.0%)
II	15 (38.5%)	16 (41.0%)
Total	39 (100%)	39 (100%)

Table 4: Hemodynamic Parameters in Clonidine Group (Group A)

Time Interval	HR (bpm)	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)
Baseline	82.1 ± 6.5	124 ± 8.2	78 ± 6.1	92 ± 6.1

5 min	78.2 ± 6.1	118 ± 7.5	75 ± 5.8	88 ± 5.9
10 min	76.5 ± 5.8	115 ± 7.1	73 ± 5.6	86 ± 5.6
20 min	75.1 ± 5.6	114 ± 6.9	72 ± 5.4	85 ± 5.4
30 min	74.8 ± 5.4	113 ± 6.5	71 ± 5.2	84 ± 5.2
40 min	75.5 ± 5.6	114 ± 6.8	72 ± 5.3	85 ± 5.3
50 min	76.2 ± 5.7	115 ± 7.0	73 ± 5.5	86 ± 5.5
60 min	76.0 ± 5.9	116 ± 7.2	74 ± 5.8	86 ± 5.8

Table 5: Hemodynamic Parameters in Magnesium Sulphate Group (Group B)

Time Interval	HR (bpm)	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)
Baseline	83.4 ± 7.1	125 ± 7.9	79 ± 6.3	93 ± 6.3
5 min	85.3 ± 7.5	121 ± 8.3	77 ± 6.1	91 ± 6.4
10 min	87.2 ± 8.2	119 ± 7.8	76 ± 6.0	92 ± 6.8
20 min	88.0 ± 7.9	120 ± 7.6	77 ± 6.2	93 ± 6.5
30 min	89.1 ± 8.5	121 ± 8.0	78 ± 6.4	94 ± 6.7
40 min	88.5 ± 8.2	122 ± 7.8	78 ± 6.3	93 ± 6.4
50 min	87.8 ± 7.9	122 ± 7.7	78 ± 6.2	92 ± 6.3
60 min	87.5 ± 7.8	122 ± 7.9	79 ± 6.2	92 ± 6.2

Table 6: Comparison of Intraoperative Heart Rate (HR) Between Study Groups

Time	Group A	Group B	p-value
Baseline	82.1 ± 6.5	83.4 ± 7.1	0.45
5 min	78.2 ± 6.1	85.3 ± 7.5	0.001
10 min	76.5 ± 5.8	87.2 ± 8.2	0.0001
20 min	75.1 ± 5.6	88.0 ± 7.9	0.0001
30 min	74.8 ± 5.4	89.1 ± 8.5	0.0001
40 min	75.5 ± 5.6	88.5 ± 8.2	0.0001
50 min	76.2 ± 5.7	87.8 ± 7.9	0.0001
60 min	76.0 ± 5.9	87.5 ± 7.8	0.0001

Table 7: Comparison of Intraoperative Systolic Blood Pressure (SBP) Between Study Groups

Time	Group A	Group B	p-value
Baseline	124 ± 8.2	125 ± 7.9	0.61
5 min	118 ± 7.5	121 ± 8.3	0.04
10 min	115 ± 7.1	119 ± 7.8	0.01
20 min	114 ± 6.9	120 ± 7.6	0.001
30 min	113 ± 6.5	121 ± 8.0	0.0001
40 min	114 ± 6.8	122 ± 7.8	0.0001
50 min	115 ± 7.0	122 ± 7.7	0.001
60 min	116 ± 7.2	122 ± 7.9	0.001

Table 8: Comparison of Intraoperative Mean Arterial Pressure (MAP) Between Study Groups

Time	Group A	Group B	p-value
Baseline	92 ± 6.1	93 ± 6.3	0.52
5 min	88 ± 5.9	91 ± 6.4	0.03
10 min	86 ± 5.6	92 ± 6.8	0.001
20 min	85 ± 5.4	93 ± 6.5	0.0001
30 min	84 ± 5.2	94 ± 6.7	0.0001
40 min	85 ± 5.3	93 ± 6.4	0.0001
50 min	86 ± 5.5	92 ± 6.3	0.001
60 min	86 ± 5.8	92 ± 6.2	0.001

Table 9: Comparison of Adverse Effects Between Study Groups

Effect	Group A	Group B
Hypotension	4 (10%)	6 (15%)
Bradycardia	5 (12%)	2 (5%)
None	30 (78%)	31 (80%)

DISCUSSION

The effects of magnesium sulphate and clonidine on intraoperative hemodynamic parameters in patients undergoing laparoscopic abdominal surgery were assessed and compared in this study. Due to pneumoperitoneum, laparoscopic procedures are linked to major hemodynamic changes, including elevated intra-abdominal pressure, hypercarbia, and sympathetic activation, which show up as tachycardia and hypertension (3,5,7,19). Maintaining intraoperative stability requires effective reduction of this stress response.

The two groups in this study had similar baseline demographics and ASA status, guaranteeing homogeneity and removing confounding bias. The validity of intergroup comparisons has been supported by similar findings reported in earlier research (14, 15, 27). Throughout the intraoperative phase, clonidine showed a notable and long-lasting decrease in blood pressure and heart rate. This is explained by its central α2-adrenergic agonist activity, which reduces catecholamine release and sympathetic outflow (9,10,33). The results are in line with previous research (14, 21, 25) that found that clonidine enhanced hemodynamic stability during laparoscopic surgeries. Magnesium sulfate, on the other hand, was less successful in regulating heart rate but offered considerable blood pressure control. It works by blocking calcium channels and preventing the release of catecholamines, which causes vasodilation (11,24). However, the comparatively elevated heart rate could be explained by its indirect effect on cardiac conduction. Tan et al. (13), Bansal K et al. (18), and Chikkanarasimha RM et al. (16) have all shown similar results.

The findings of the present study are consistent with both international and Indian literature, which have reported superior hemodynamic stability with clonidine compared to magnesium sulphate during laparoscopic surgeries. Overall, clonidine demonstrated more consistent and effective control of intraoperative hemodynamic parameters, making it a preferable agent for attenuating the stress response to pneumoperitoneum.

The results of this study are in line with research from India and other countries that has shown that clonidine provides better hemodynamic stability during laparoscopic procedures than magnesium sulphate. Clonidine is a better medication for reducing the stress response to pneumoperitoneum because it generally showed more reliable and efficient regulation of intraoperative hemodynamic parameters.

CONCLUSION

During laparoscopic surgery, clonidine and magnesium sulfate both successfully reduce the hemodynamic reaction to pneumoperitoneum. Clonidine, on the other hand, considerably improves intraoperative hemodynamic stability by reducing and controlling heart rate, systolic blood pressure, and mean arterial pressure. Although it is less successful in controlling heart rate, magnesium sulfate provides moderate blood pressure management. Both groups experienced mild side effects, but they were clinically treatable and not statistically significant. Therefore, clonidine seems to be a more dependable and successful medication for preserving intraoperative hemodynamic stability during laparoscopic abdominal procedures.

LIMITATIONS

The current study has some drawbacks despite its advantages. The results may not be as broadly applicable due to the comparatively small sample size (n=78). Due to the study's single-center design, external validity might be limited. The study did not evaluate long-term results or postoperative recovery; instead, it concentrated solely on intraoperative hemodynamic measures. Furthermore, sophisticated metrics including stress hormone response, depth of anesthesia monitoring, and serum catecholamine levels were not assessed. Without investigating dose-response relationships, which could affect hemodynamic effects, fixed drug dosages were employed. Despite the double-blind methodology of the study, minimal observer bias cannot be totally ruled out.

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