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RESEARCH ARTICLE
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A CLINICAL STUDY FOR COMPARISON OF MAGNESIUM SULPHATE AND DEXMEDETOMIDINE AS COMPONENTS OF OPIOID FREE MULTIMODAL ANALGESIA REGIMEN IN PATIENTS UNDERGOING LAPAROSCOPIC CHOLECYSTECTOMY UNDER GENERAL ANAESTHESIA.

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Abstract:
Introduction: Opioids are established drugs used for alleviating pain in surgeries, but they have multiple side effects. Dexmedetomidine and magnesium sulphate are being used as alternatives to overcome opioid related side effects. Objectives: To compare the duration of analgesia post-operatively in terms of time to first rescue analgesia. To estimate the total number of doses of injection Tramadol required in 24 hours postoperatively. To compare intraoperative hemodynamic stability in terms of change in HR and MAP post intubation, incision, and after creation of pneumoperitoneum. Methods: After IEC clearance, patients undergoing laparoscopic cholecystectomy were allocated to groups D and M (38 each). Group D was given Inj. Dexmedetomidine 1 mcg/kg as a bolus followed by 0.5 mcg/kg/hr as maintenance. Group M was given Inj. Magnesium sulphate 50 mg/kg as a bolus followed by 15 mg/kg/hr as maintenance. In both groups, Inj. Diclofenac 75mg and Inj. Nefopam 20 mg was given pre-emptively before induction as part of multimodal analgesia. Heart rate and mean arterial pressure were recorded at fixed intervals. Inj. Paracetamol 1gm was given as 1st rescue analgesia and Inj. Tramadol was given if the patient had persistent pain even after giving paracetamol. Time to demand rescue analgesia and the total number of tramadol doses required during 24 hours were recorded at VAS score >/= 4. Results: Results demonstrated that dexmedetomidine provided better hemodynamic stability with longer postoperative analgesia compared to magnesium sulphate.

The total number of Tramadol doses required in the Dexmedetomidine group was less compared to the Magnesium sulphate group. Conclusion: Both magnesium sulphate and dexmedetomidine have good peri-operative analgesic effects with increased time to rescue analgesia and decreased opioid consumption with good hemodynamic stability peri-operatively. Hence, it can be used as an alternative to opioids in perioperative pain management.

Key Words: Dexmedetomidine, Magnesium sulphate, pre-emptive analgesia, multimodal analgesia.

Introduction:

Acute post-operative pain in laparoscopic cholecystectomy is considered to be less intense than that of open cholecystectomy, but it contributes to morbidity and delays postoperative recovery and discharge.[1] Acute pain after laparoscopic cholecystectomy has three components: somatic component at the incision site, visceral component in deep intra-abdominal organs, and referred pain at the shoulder tip.[2] Pneumoperitoneum creation during laparoscopic procedures leads to hemodynamic changes. There is activation of the sympathetic system and the neuroendocrine pathway, increasing the levels of catecholamines, renin, vasopressin, prostaglandins, and cortisol.[3,4] The hemodynamic changes may even predispose the myocardium to life-threatening ischemia.[5]

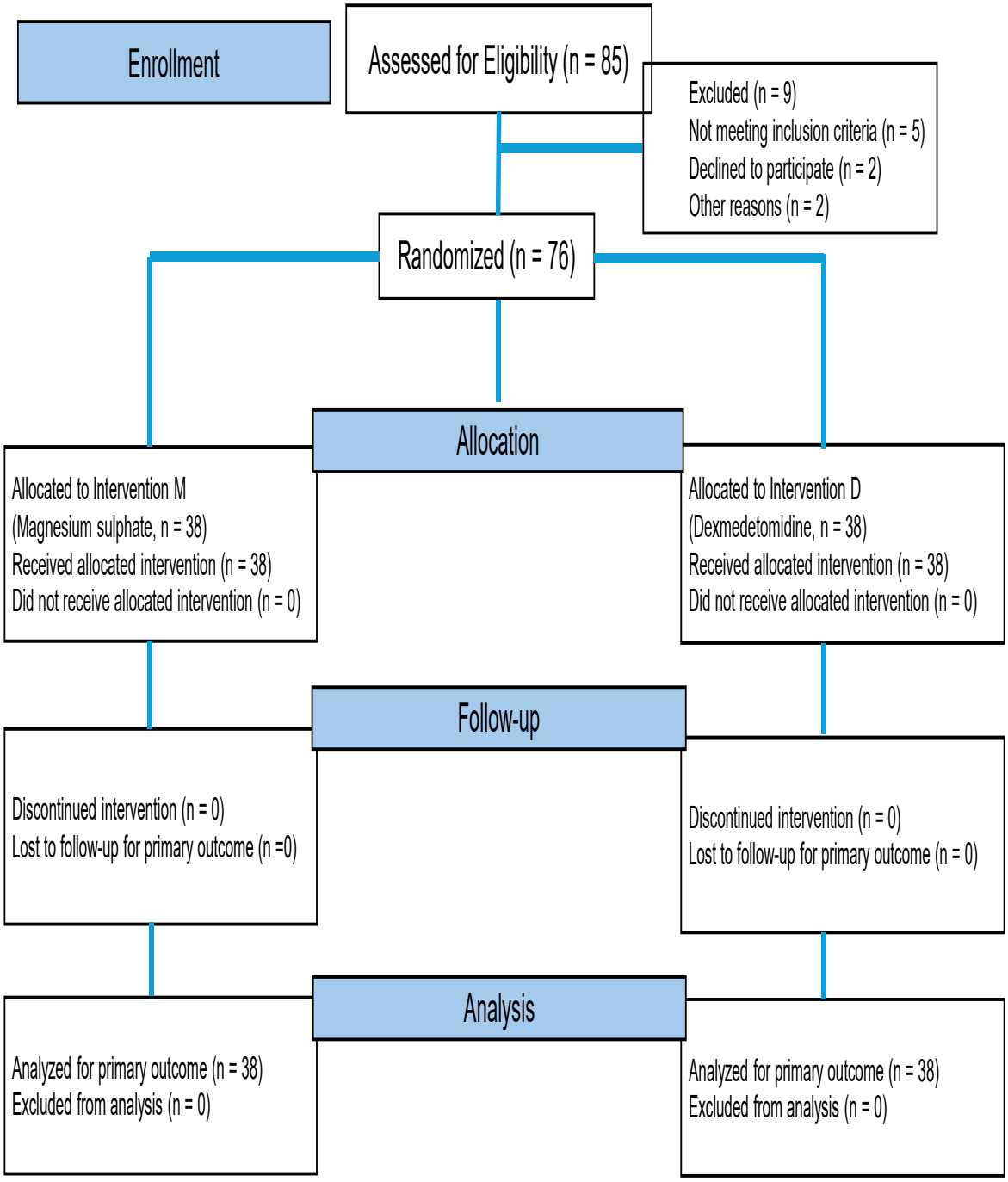
Good analgesia is also required for optimal hemodynamic management. Multimodal analgesia (MMA) utilises multiple analgesic agents targeting different sites of the pain pathways. Traditionally, opioids have been used for perioperative analgesia and to attenuate autonomic responses to noxious stimuli. But their use comes along with a number of side effects such as respiratory depression, dizziness, orthostatic hypotension, nausea, vomiting, urinary retention and ileus.[1,6,7] All these may delay recovery, resulting in delayed discharge and increased economic burden.

Magnesium sulphate (MgSO4) and dexmedetomidine are amongst such drugs being explored as alternatives to opioids. Magnesium sulphate's role in perioperative analgesia is increasingly attributed to its ability to reduce central sensitisation and prevent opioid-induced hyperalgesia through sustained NMDA receptor antagonism.[3,8,9] Dexmedetomidine is a highly selective alpha-2 adrenergic receptor agonist used for analgesia and peri-operative sympatholysis[1,4,10]. Beyond analgesia, dexmedetomidine has been shown to improve quality of recovery scores and patient satisfaction following laparoscopic surgeries due to its sedative-analgesic efficacy without respiratory depression.[11] The present study was planned to compare magnesium sulphate and dexmedetomidine as components of MMA to avoid opioid related side effects.

Material and methods:

After approval from the IEC of T.S.M. Medical College & Hospital, Lucknow, the present study was conducted in adult patients undergoing laparoscopic cholecystectomy.

Patients were assigned to one of two groups, with 38 patients in each group using the chit in the box method. Group M- Magnesium sulphate group. Group D- Dexmedetomidine group. Inclusion criteria were patients scheduled for elective laparoscopic cholecystectomy under general anaesthesia. Age 18-65 years of either sex, ASA physical status I-II, patient consent to participate in the study. Exclusion criteria were pregnant and lactating women, body mass index > 35 kg/m2, patients with known hypersensitivity or allergic to the study drug, laparoscopic procedure converted to open cholecystectomy or duration of surgery more than 2 hours



Consort flow diagram

After allocating patients to respective groups using the chit in the box method, they were taken to OT and connected to the monitors. Baseline hemodynamic parameters: heart rate (HR) and mean arterial pressure (MAP) were recorded. Both groups were given Inj. diclofenac 75 mg in 100ml NS and Inj. nefopam 20 mg in 100 ml NS intravenous (iv) slowly. Patients in group D were given a loading dose of Inj. dexmedetomidine 1.0 mcg/kg over 10 minutes followed by maintenance infusion at 0.5 mcg/kg/hour iv. Patients in group M were given Inj. MgSO4 50 mg/kg over 15 minutes as loading, followed by 15 mg/kg/hour iv. as maintenance. Premedication was done with Inj. midazolam 2 mg iv followed by induction with incremental doses of propofol. Inj. vecuronium 0.1 mg/kg iv was administered after checking for adequacy of ventilation, followed by laryngoscopy and endotracheal intubation after 3 minutes. Anaesthesia was maintained by isoflurane 0.8 -1 MAC along with oxygen and nitrous oxide. Local infiltration with a total mixture of 3ml of 1% lignocaine (1.5 ml) and 0.25%

bupivacaine (1.5 ml) at each port site was also given before skin incision as part of MMA. HR and MAP were recorded just after infusion of the study drug, at intubation and every 5 minutes until 30 minutes after creation of pneumoperitoneum.
During surgery, any event of increase or decrease in MAP or HR up to 20% from the baseline was managed by increasing or decreasing the infusion rate of dexmedetomidine or magnesium sulphate. In the event of a decrease, both infusions were halved. Similarly, in events of increased HR/MAP to 20% from baseline, both infusions were doubled. Any decrease in HR greater than 30% from baseline, or HR <45/min, was managed with Inj. atropine 0.6 mg iv bolus whereas an increase >30% was managed by Inj. esmolol 0.5 mg/kg iv and a decreased MAP of >30% was managed by inj. mephentermine 6mg iv bolus. Cases with a persistent increase in MAP above 30% were managed with nitroglycerine infusion at 5 mcg/kg/min. Intra-abdominal pressure was maintained within 10-12 mmHg, and complete desufflation of the abdomen was ensured at the end of surgery. MgSO4 or dexmedetomidine infusion was discontinued once the gallbladder was removed. Patients were extubated according to standard protocol. In the postoperative area, visual analog scale (VAS) scores were recorded at 0 min, 15 min, 30 min, 1 hour, 2 hours, 4 hours, and every 4 hours thereafter until 24 hours. The time to demand for rescue analgesia was recorded from extubation until the patient complained of pain with a VAS score >/= 4/10. Inj. paracetamol 15 mg/kg iv was administered as first rescue analgesia & continued 6 hourly thereafter for 24 hrs. In case of VAS score >/= 4 even after paracetamol, inj. tramadol 100 mg slow iv was given, and the total number of doses of tramadol required in 24 hours was noted.

Statistical Analysis:
Statistical testing was conducted with the latest available version of the statistical package for social sciences software. Continuous variables such as height, weight, and body mass index (BMI) were presented as mean ± SD and compared using unpaired t-tests. Age is a continuous variable and was compared using t test. Nominal categorical data, such as gender were compared using the chi-square test. Heart rate and mean arterial pressure were compared using unpaired t-test. The normality of the data was checked by the Kolmogorov-Smirnov test. Non-normal data, such as the total number of paracetamol and tramadol doses for rescue analgesia, were calculated using the Mann-Whitney U test. A p-value of < 0.05 was considered statistically significant.
Sample size calculation
Sample size is calculated based on the variation in time to 1st rescue analgesia between two comparative groups.[3]
By using the formula,
$n = k (Z_{\alpha/2} + Z_{\beta})^2 (\sigma1^2 + \sigma2^2) / d^2$
Where $\sigma1 = 1.14$, the SD of Time to 1st rescue analgesia in dexmedetomidine group and $\sigma2 = 1.60$, the SD of time to 1st rescue analgesia in magnesium sulphate group, $d = \min(\sigma1, \sigma2)$, the minimum difference considered to be clinically significant, $k = 1.0$ the design effect, type I error $\alpha = 5\%$ corresponding to 95% confidence level, type II error $\beta = 10\%$ for detecting results with 90% power of study. The minimum sample size was calculated to be $n = 38$ patients in each group.

Results:
The age and anthropometric measurements such as height, weight, BMI, gender, ASA physical status were comparable between the two groups.

Table-1 : Distribution of subjects according to anthropometry.

Baseline characteristics	Group M		Group D		
	Mean	SD	Mean	SD	p-value
AGE	41.30	13.17	41.90	9.90	0.822
HEIGHT	160.14	7.76	159.95	9.43	0.925
WEIGHT	59.54	7.01	60.00	7.80	0.788
BMI	23.17	1.44	23.32	1.92	0.702

Table – 2 : Distribution of subjects according to gender & ASA grade

Variable		group			
		Group M		Group D	
		No.	%	No.	%
GENDER	Female	30	78.9%	34	89.5%
	Male	8	21.1%	4	10.5%
	significance	chi sq=1.58, p=0.208			
ASA PHYSICAL STATUS	Grade I	30	78.9%	30	78.9%
	Grade II	8	21.1%	8	21.1%
	significance	chi sq=0.00, p=1.000			

Table 3 : Time to first rescue analgesia

Group	**Time to first Rescue Analgesia (hr)**		
	Mean	SD	p-value
Group M	4.20	3.70	0.238
Group D	5.16	3.36	

The mean time to first rescue analgesia was 4.20 hours (SD of 3.70) for Group M, and 5.16 hours (SD of3.36) for Group D.Theunpairedt-testyieldedap-valueof0.238, with the difference being not statistically significant.

Table 4 : Comparison of total doses of rescue analgesia

Rescue Analgesia in 24 hr	Group M		Group D		Mann Whitney test
	Mean	SD	Mean	SD	p-value
TOTAL NO. OF PCM DOSE	3.11	0.7	3.03	0.5	0.524
TOTAL NO. OF TRAMADOL DOSES	0.51	0.7	0.15	0.4	**0.006**

The evaluation of rescue analgesia within a 24-hour period (table 4) showed that the mean total number of PCM doses required for group M was 3.11with a standard deviation of 0.7, while fo rgroup D, it was 3.03 with a standard deviation of 0.5. The Mann-Whitney test yielded a p-value of 0.524, indicating that the difference in the total number of PCM doses used between the two groups was not statistically significant.

Table 5 : Total number of tramadol doses in 24 hrs

Variables	**Group**

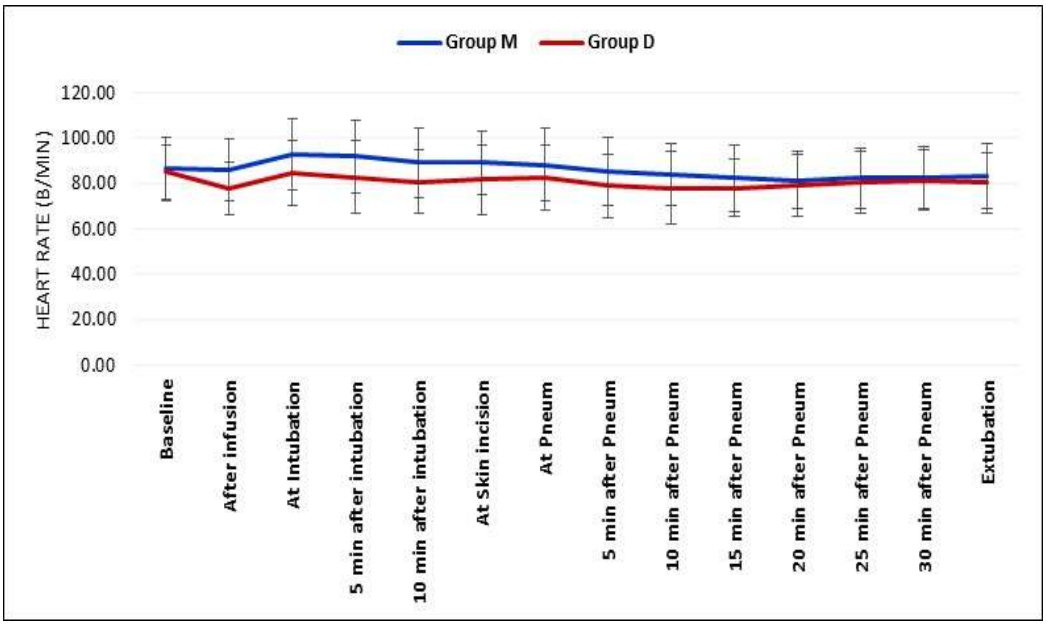
		Group M		Group D	
		No	%	No	%
TOTAL NO OF TRAMADOL DOSES IN 24 HRS	zero	23	60.5	33	86.8
	one	11	28.9	4	10.5
	two	4	10.5	1	2.6
	significance	Chi sq = 6.85, p=0.033			

The mean total number of tramadol doses required over 24 hrs for rescue analgesia (table 5) showed that group M had a higher mean of 0.51 tramadol doses with a SD of 0.7, whereas group D had a lower mean of 0.15 doses with a SD of0.4. The Mann-Whitney test yielded a statistically significant difference ($p < 0.05$). The percentage of patients requiring tramadol in24 hrs was also analysed. In Group M, 23 individuals (60.5%) reported zero doses,11individuals(28.9%)reported one dose, and 4 individuals(10.5%) reported two doses. In contrast, in group D, a higher proportion of individuals reported zero doses, with 33 individuals (86.8%), while only 4 individuals (10.5%) reported one dose, and 1 individual (2.6%) reported two doses. A chi-square test indicated a statistically significant difference between the groups (p=0.033).

Table 6 : intergroup comparison of heart rates

Heart Rate	Group M		Group D		
	Mean	SD	Mean	SD	p-value
Baseline	86.27	14.19	85.00	12.15	0.676
After infusion	86.05	13.77	77.95	11.57	**0.007**
At Intubation	92.82	15.70	84.53	14.25	**0.018**
5 min after intubation	91.97	15.95	82.85	16.16	**0.016**
10 min after intubation	89.03	15.38	80.68	13.92	**0.015**
At Skin incision	89.05	13.74	81.55	15.15	**0.027**
At Pneumoperitoneum	88.29	16.04	82.55	14.28	0.104
5 min after Pneumoperitoneum	85.51	15.04	78.82	13.92	**0.048**
10 min after Pneumoperitoneum	84.00	13.62	77.97	15.84	0.079
15 min after Pneumoperitoneum	82.21	14.51	77.95	12.72	0.177
20 min after Pneumoperitoneum	81.26	12.69	79.13	13.69	0.484
25 min after Pneumoperitoneum	82.29	13.4	80.26	13.50	0.512
30 min after Pneumoperitoneum	82.47	13.79	81.37	13.26	0.723
Extubation	83.24	14.59	80.34	13.30	0.369

Figure 1 - Comparison of heart rate



The baseline heart rate was comparable between the two groups. Following infusion of study drug, group M had a mean heart rate of 86.05 beats per minute (SD = 13.77), whereas group D had asignificantly lower mean heart rate of 77.95 beats per minute (SD = 11.57). At intubation, 5 and 10 minutes after intubation and at skin incision, heart rateincreased in group M whereas remained around the baseline in group D, with statistically significant differences observed at each time point ($p<0.05$).

Two patients in group D demonstrated decrease in heart rate by 20% whichwas managed by decreasing the infusion rate of dexmedetomidine to 0.25 mcg/kg/hr.

Table 7 : Intragroup changes in heart rate during the observation period

Heart Rate	Group M			Group D		
	change from BL	SD of change	p-value	change from BL	SD of change	p-value
After infusion	-0.16	0.82	0.244	-7.08	5.29	**<0.001**
At Intubation	6.61	12.34	**0.002**	-0.50	11.03	0.781
5 min after intubation	5.76	13.29	**0.011**	-2.42	14.24	0.301
10 min after intubation	2.82	13.39	0.203	-4.34	14.71	0.077
At Skin incision	2.84	12.33	0.164	-3.47	15.67	0.180
At Pneumoperitoneum	2.08	14.37	0.378	-2.47	13.89	0.279
5 min after Pneumoperitoneum	-0.53	14.96	0.830	-6.55	14.83	**0.010**
10 min after Pneumoperitoneum	-2.21	13.98	0.336	-7.05	14.62	**0.005**

15 min after Pneumoperitoneum	-4.00	15.19	0.113	-7.08	13.36	0.052
20 min after Pneumoperitoneum	-4.95	14.30	0.040	-5.89	14.58	0.051
25 min after Pneumoperitoneum	-3.92	14.94	0.114	-4.76	14.01	0.053
30 min after Pneumoperitoneum	-3.74	12.85	0.081	-3.66	13.76	0.110
Extubation	-2.97	15.62	0.248	-4.68	13.67	0.063

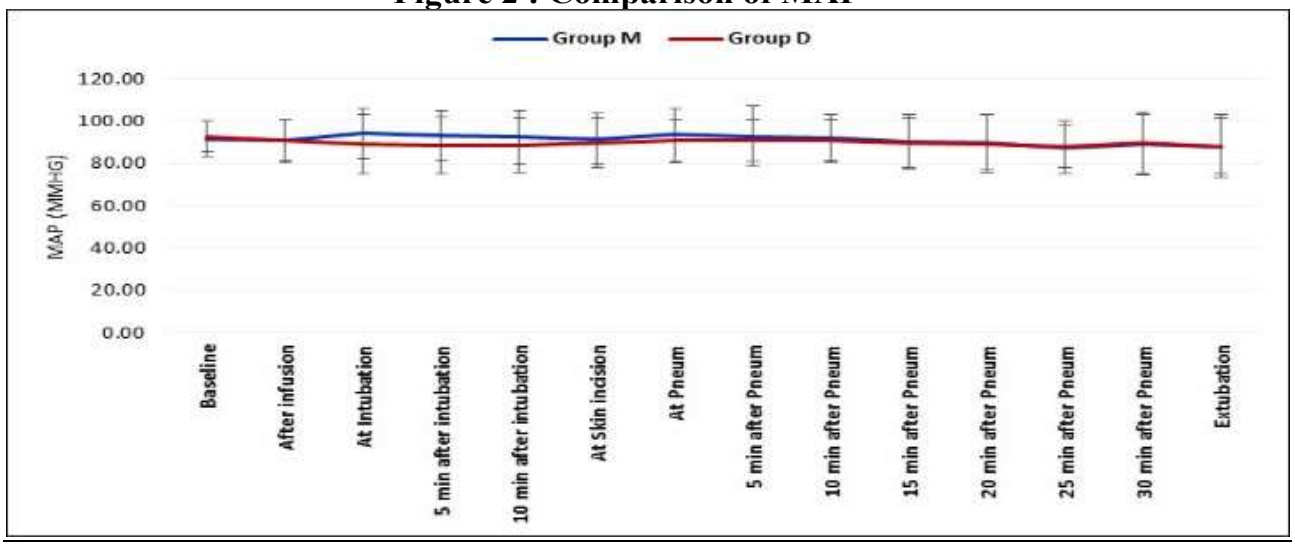
The table no 7 demonstrates changes in heart ratefrom thebaseline(BL)within thegroupsMand D. Following infusion of study drugs, group M exhibited a negligible decrease in heart rate of-0.16beatsperminute(SD=0.82), whichwasnotstatisticallys ignificant(p=0.244).In contrast,groupDexperiencedalargerdecreaseof-7.08beatsperminute(SD=5.29) which was statistically significant p (0.001). At intubation and after 5 minutes, group M showedastatisticallysignif icantincreaseinheartrateby6.61beatsperminuteand5.76beats per minute respectively, (SD =12.34, p =0.002), (SD =13.29, p =0.011) whereas group D demonstrateda non significantdecreaseof-0.50beatsperminute(SD=11.03,p=0.781). 10minutesafterintubationheartratechangesingroupMandgroupDfromthebaselinewerestat isticallynotsignificant.5, 10 and 15 minutes after creation of pneumoperitoneum, group D displayed statistically significant decrease in heart rate responses.

Table 8 : Intergroup comparison of MAP during the observation period

MAP	Group M		Group D		
	Mean	SD	Mean	SD	p-value
Baseline	91.74	8.38	92.87	7.32	0.533
After infusion	90.92	9.64	90.68	10.12	0.917
At Intubation	94.16	11.79	89.37	13.95	0.110
5 min after intubation	93.24	11.76	88.39	13.37	0.098
10 min after intubation	92.37	12.53	88.63	12.79	0.202
At Skin incision	91.74	11.91	89.71	11.92	0.461
5 min after Pneumoperitoneum	92.87	14.22	90.89	9.69	0.482
10 min after Pneumoperitoneum	92.16	10.82	90.71	10.28	0.552
15 min after Pneumoperitoneum	90.47	12.85	89.74	11.38	0.792
20 min after Pneumoperitoneum	89.78	13.08	89.38	13.76	0.897
25 min after Pneumoperitoneum	87.58	12.54	88.16	9.97	0.824
30 min after Pneumoperitoneum	89.14	14.07	89.46	14.71	0.922

At extubation	88.08	14.91	88.18	13.15	0.974

Figure 2 : Comparison of MAP



The provided table no 8 and figure 2outlines MAP. The baseline values were comparable between the two groups. Time points following infusion, a tin tubation and post- intubation periods, group M exhibited higher mean MAP compared to group D, but the difference between the two groups was statistically not significant.

Table 9 : Intragroup changes in MAP during the observation period

Group M			Group D		
change from BL	SD of change	p-value	change from BL	SD of change	p-value
-0.82	7.06	0.481	-2.18	11.22	0.238
2.42	10.99	0.183	-3.50	15.12	0.162
1.50	10.87	0.401	-4.47	14.43	0.064
0.63	10.41	0.711	-4.24	13.82	0.067
0.00	11.69	1.000	-3.16	12.81	0.137
1.95	14.92	0.426	-2.21	11.37	0.239
1.13	16.11	0.668	-1.97	10.90	0.271
0.42	13.43	0.848	-2.16	11.33	0.248
-1.26	16.54	0.641	-3.13	13.28	0.154
-1.95	16.62	0.475	-4.39	14.24	0.065
-4.16	16.01	0.118	-4.71	11.28	0.051
-2.50	15.01	0.311	-3.50	16.55	0.200

-3.66	16.77	0.187	-4.68	14.09	0.054

The changes in MAP from the baseline within group M and group D following infusion of study drug , during and after intubation group M demonstrated a non significant increase in MAP from the baseline where as group D demonstrated a decrease in MAP when compared to baseline and the changes were not significant (p 0.05).

Discussion:

Effective pain management and early recovery is the key components in the peri-operative care to ensure optimal outcomes for surgical patients. The current emphasis has shifted towards opioid-free protocols aimed at minimising opioid-related adverse effects while ensuring adequate analgesia, hemodynamic stability, and early discharge. Recent enhanced recovery after surgery (ERAS) protocols strongly advocate opioid-sparing or opioid-free anesthetic techniques, emphasising multimodal analgesia to improve postoperative recovery and reduce opioid-related morbidity. The present study was conducted to compare magnesium sulphate and dexmedetomidine as components of opioid-free multimodal analgesia.

Patients in group D were given a loading dose of injection dexmedetomidine 1.0 mcg/kg over 10 minutes, followed by maintenance infusion at 0.5 mcg/kg/hour intravenously. This dosing strategy was selected to balance analgesic efficacy with cardiovascular safety, avoiding excessive sympatholysis. Siddiqui et al. and Panchgar et al. demonstrated similar infusion protocols with favorable analgesic and hemodynamic outcomes.[1,10].

Manne G. R. et al. in their study found that dexmedetomidine at a dose of 0.2 µg/Kg/hour was less effective and required early first rescue analgesia.[5]Hence, in the present study, an infusion rate above 0.2 µg/kg/h was employed, while avoiding higher doses that could predispose patients to clinically significant bradycardia or hypotension.

Magnesium sulphate was administered as a bolus of 50 mg/kg, followed by a maintenance infusion of 15 mg/kg/h, consistent with prior studies evaluating its analgesic adjuvant role. Ryu et al. demonstrated that magnesium sulphate significantly reduced postoperative pain scores and cumulative analgesic consumption.[12]

Duration of analgesia

Injection paracetamol 15mg/kg was administered as first rescue analgesia. The mean time to first rescue analgesia for group M was 4.20 +/- 3.70, while for group D, it was 5.16 +/- 3.36 (p>0.05). There was lack of statistical significance in the mean time to first rescue analgesia in both the groups. Farouk I. et al in their study on 60 patients undergoing inguinal surgery under spinal anesthesia observed that the effects on duration of sensory, motor blockade and analgesia. They demonstrated prolonged analgesia with both dexmedetomidine and magnesium sulphate compared to placebo, with dexmedetomidine showing the longest duration of analgesia of 5.8 hrs.[13]

Panchgar V. et al. found that the mean time to rescue analgesia was 360 minutes for dexmedetomidine group as compared to normal saline group. They used higher VAS scores (more than 5) to administer first-rescue analgesia.[10] Santpur et al., in their study on 60 patients undergoing spinal anaesthesia, were given similar infusion doses of dexmedetomidine (group 1) or normal saline as a placebo (group 2). They observed that the duration of analgesia was significantly higher in group 1 (219.7 ± 2.55 minutes) than in Group 2 (150.2 ± 5), with $p<0.05$.[14]

Requirement of rescue analgesia

The mean total number of PCM doses used for rescue analgesia in the two groups was statistically insignificant. Since there was no difference in the time to first rescue analgesia by paracetamol, and once administered it was repeated every 6 hourly, there was no difference found in the total number of paracetamol, doses.

Tramadol was used in cases of failed rescue analgesia with paracetamol, and the mean total number of doses required was calculated. Group M had a statistically significant higher mean total of 0.51 with a standard deviation of 0.7 than group D. The significantly lower requirement for rescue tramadol in the dexmedetomidine group depicts its superior opioid sparing efficacy compared with magnesium sulfate. Although both agents possess antinociceptive properties, their mechanisms differ in potency and clinical impact. Dexmedetomidine exerts its analgesic effect through highly selective α2-adrenergic receptor activation at both supraspinal (locus coeruleus) and spinal (dorsal horn) levels, resulting in inhibition of norepinephrine release, attenuation of substance P transmission, and enhancement of descending inhibitory pain pathways. This multimodal modulation of nociceptive processing reduces central sensitization and decreases the perioperative stress response, thereby decreasing postoperative opioid requirements. In contrast, magnesium sulfate primarily acts as an NMDA receptor antagonist, limiting calcium influx and mitigating excitatory neurotransmission; however, its analgesic effect is indirect.

Notably, 86.8% of patients in the dexmedetomidine group did not require tramadol compared to 60.5% in the magnesium group. The difference between the two groups was statistically significant.

Lang B. et al. had conducted a meta-analysis to compare dexmedetomidine and magnesium sulphate for their effects and safety. Both groups were shown to have decreased opioid consumption (29.13% with magnesium group vs 10.78% with dexmedetomidine group).[15]Panchgar et al. similarly demonstrated reduced postoperative opioid requirements with dexmedetomidine infusion.[10] These findings reinforce role of dexmedetomidine as an effective opioid substitute in multimodal analgesic strategies.

Heart Rate

After infusion of study drugs, both groups demonstrated a fall in heart rate from baseline. Dexmedetomidine group demonstrated a statistically significant decrease in heart rate as compared to Magnesium sulfate group. Dexmedetomidine produces analgesia by activating central α2-adrenergic receptors, leading to inhibition of substance P release and reduced sympathetic outflow, thereby attenuating tachycardia and hypertension associated with laryngoscopy, intubation, and pneumoperitoneum. Farouk et al. also observed a similar decrease in heart rate after dexmedetomidine infusion.[13] Similar observations were reported by Panchgar et al. and Sharma et al. In their study, Sharma et al. compared dexmedetomidine with normal saline. They observed that the dexmedetomidine group demonstrated a significant decrease in heart rate after infusion, followed by a non-significant increase at the time of intubation.[16]

Goarya R.Setal observed an increase in heart rate at intubation and 5 minutes after intubation in magnesium sulfate group compared to fentanyl group but the difference was not significant ($p>0.05$).[8] In our study10 minutes after intubation, at skin incision, and 5 mins after pneumoperitoneum creation, group D consistently exhibited lowermeanheartrate scomparedtogroupMwithstatisticallysignificantdifferencesobserved at each time point ($p <0.05$). However, the rise in heart rate from the baseline in group M was not statistically significant. This highlights dexmedetomidine's superior ability to blunt sympathetic responses to noxious stimuli. Although with magnesium sulfate the changes in heart rate from the baseline were statistically not significant. Sebastiao E.S. Filho at el. found similar increase in heart rate after intubation, skin incision and pneumoperitoneum in magnesium sulfate group as compared to dexmedetomidine group.However the difference between the two groups was statistically not significant.[7]

Dexmedetomidine group had an exaggerated fall in heart rate from the baseline 5 and 10 minutes after pneumoperitoneum. This could be attributed to the combined effects of sympatholys is caused by the drug dexmedetomidine itself and vagal stimulation due to the peritoneal stretching at the time of creation of pneumoperitoneum. This fall from the baseline in group D was statistically significant at both time points with p values of 0.01 and 0.005. Inboth the groups there was further decrease in heart rate at 15 minutes after pneumoperitoneum

till extubation. Goarya R.S. et al also observed similar fall in heart rate towards the end of surgery in magnesium sulphate group which was not significant.[8]
Ali H.S.M et al in their study included 105 patients posted for laparoscopic cholecystectomy where group C received i.v. infusion of clonidine 1.5 µg/kg, group M received i.v. infusion of magnesium sulfate 30 mg/kg or group S received i.v. infusion of isotonic saline before induction of anesthesia. They found that HR was significantly lower in group C than that in groups M and S after induction, at pneumoperitoneum, after 15 mins and 30 mins of pneumoperitoneum, similar to our findings.[3] Lang B et al in their meta analysis to compare the effects and safety in providing controlled hypotension observed that the heart rate was significantly lower in patients who had received dexmedetomidine compared to the patients receiving magnesiumsulphate.[15] ButFaroukI etal in their study had concluded that neither dexmedetomidine nor magnesiumsulphate infusion cause any significant changes in heart rate.[13]

MeanArterialPressure (MAP)

Both groups showed a mild, non-significant reduction in MAP following infusion. Magnesium sulphate induces vasodilation by inhibiting catecholamine release, while dexmedetomidine reduces sympathetic tone centrally. Ali et al. reported significant MAP reductions with magnesium sulfate and clonidine compared to placebo.[3] A comparative trial demonstrated that while both dexmedetomidine and magnesium sulphate blunt perioperative sympathetic responses, dexmedetomidine provides more predictable heart rate control with comparable blood pressure stability.[17]
In the present study, MAP responses during intubation, skin incision, and pneumoperitoneum were comparable between groups, with no clinically significant hypotension observed. This suggests that both agents provide effective attenuation of stress-induced hemodynamic fluctuations when used as part of a balanced MMA regimen.
.No side effects commonly observed with opioids such as nausea etc were observed in any group.

Limitation:

A limitation of this study is the absence of a conventional opioid-based control group, which would have allowed direct comparison and stronger validation of opioid-free superiority. Another limitation is we used tramadol in the postoperative period as recue analgesia. Another limitation is the unblinding of the study.

Conclusion:

Safe management of post-operative pain is a challenge for an anaesthesiologist and MMA can be administered to reduce requirements of both inhalational anaesthetic agents as well as opioids. The findings of the present study demonstrate that both dexmedetomidine and magnesium sulphate effectively enhance postoperative analgesia and attenuate perioperative hemodynamic responses when incorporated into an opioid-free MMA protocol. Dexmedetomidine, however, offers superior heart rate control, and greater opioid-sparing benefits. Importantly, no opioid-related adverse effects such as nausea, vomiting, or respiratory depression were observed in either group.
Consequently, both agents facilitate effective opioid-sparing analgesia while maintaining cardiovascular stability, making them valuable components of opioid-free multimodal analgesia protocols in laparoscopic surgery.

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