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ORIGINAL RESEARCH

Effect of Dexmedetomidine and Magnesium Sulphate in Control of Shivering Under Neuraxial Anaesthesia in Patients Undergoing Lower Limb and Lower Abdominal Surgeries

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ABSTRACT

Background: To assess and contrast the effectiveness, hemodynamic stability, and side effects of dexmedetomidine and magnesium sulphate when used to reduce intraoperative shivering.

Methods: The study was conducted at Department of Anesthesiology at Government general hospital, Guntur, India from January 2021 to March 2022. The study was performed on 100 patients undergoing lower abdominal and lower limb surgeries under neuraxial anesthesia.

Result: In the magnesium sulphate group, it took an average of 3.88±0.25 mins for the shivering to stop, but in the dexmedetomidine group, it took an average of 2.18±0.26 mins. The shivering score of magnesium sulphate and dexmedetomidine was 3±0 mins. Magnesium sulphate was provided in one case, and no one in the dexmedetomidine group experienced shivering again.

Conclusion: Together, dexmedetomidine 1 mcg/kg and magnesium sulphate 50 mcg/kg significantly decreased intraoperative shivering. Dexmedetomidine stopped the shivering in the shortest length of time while simultaneously raising body warmth and maintaining reduced pulse and respiratory rates.

Keywords: Neuraxial anesthesia, shivering score, dexmedetomidine.

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INTRODUCTION

Uncontrollable contractions of one or more muscular groups are known as shivering. Shivering can also be brought on by other factors such pain, diminished sympathetic activity, unchecked spinal reflux, cytokine release, and adrenal suppression.[1-3] The unifying factor, however, is impaired thermoregulation brought on by hypothermia brought on by a 0.5–1°C drop in core heat. Shivering interferes with the assessment of NIBP, ECG, and oxygen consumption, which raises cardiac output and respiration and leads to cardiac failure in elderly individuals or those who already have a cardiac or respiratory condition. Shivering may also result in lactic acidosis, increased carbon dioxide generation, muscle exhaustion, increased intraocular pressure (IOP), and increased intracranial tension (ICT). The patient may have increased pain at the surgery site and hypothermia until the effects of blocking vanish below the block level. Regional anaesthesia impairs sensory impulses travelling from

the lower limbs to the brain, which also causes a reduction in heat output. In comparison to general anaesthesia, the patient's rewarm-up time nearly doubles when under regional anaesthetic.[3,4] Intraoperative shivering has been prevented and treated with a variety of pharmaceutical and non-pharmacological strategies. Non-pharmacological treatments include keeping the patient warm before and during surgery, using warm blankets to prevent hypothermia, breathing humid oxygen, and regulating the temperature in the operating room. Another non-pharmacological approach is to keep the skin warm because when the skin is warmed, the body's thermoregulation can tolerate central hypothermia. However, this approach works best when the body's core temperature is higher than 35 °C. The shivering threshold is mostly lowered by pharmaceutical techniques.[5,6] Meperidine, clonidine, ketanserin, magnesium sulphate, and physostigmine are just a few of the medications that can effectively decrease intraoperative shivering. All of these medications have unwanted side effects, including lowered consciousness and respiratory centre depression. They can also produce nausea, vomiting, and itching, which is distressing for the patient while they are under regional anaesthesia.[7-9] The purpose of the current study was to assess and compare the effectiveness, hemodynamic effects, and side effects of using magnesium sulphate and dexmedetomidine to manage intraoperative shivering.

MATERIALS AND METHODS

From 15 months, the study was carried out at the Government General Hospital in Guntur, India, Department of Anesthesiology (January 2021 to March 2022). 100 patients who were having lower abdominal and lower limb procedures while under neuraxial anesthesia participated in the study. Patients in the age range of 20 to 60 who were admitted to Guntur Government Hospital between January 2021 to March 2022 with plans for lower abdomen and lower limb procedures and who had provided written informed consent from patients or guardians were included in the prospective study. Patients experiencing intraoperative shivering during lower abdomen and lower limb procedures under neuraxial anesthesia will be randomly assigned to one of two groups. Magnesium sulphate 50mg/kg IV bolus will be administered to Group A (50 patients). Dexmedetomidine 1 microgram/kg IV will be administered to Group B (50 patients).

Inclusion Criteria:

1. Included age between 20- and 60-years age
2. Lower limb and lower abdominal surgeries
3. ASA grade 1 and 2

Exclusion Criteria:

1. Hypersensitivity to the drugs
2. Cardiovascular disorders
3. Any hepatic diseases OR any renal impairment
4. Neurological and psychiatric diseases
5. Any neuromuscular diseases
6. Perioperative febrile conditon

RESULTS

Table 1: Age distribution

	Magnesium sulphate	**Dexmedetomidine**
20 – 30	14 (28%)	12 (24.0%)
31 – 40	19 (38%)	14 (28.0%)

41 – 50	11 (22%)	16 (32.0%)
51 – 60	6 (12%)	8 (16.0%)
Total	50 (100%)	50 (100.0%)
Mean ± SD	38.32 ± 9.33	39.82 ± 9.59
Chi square test = 2.12, p =0.54, Not statistically significant		

In the present study, 26% of the patients were aged 20-30 years, 33% were aged 31-40 years, 17% were aged between 41-50 years, 14% were aged between 51-60 years.The mean age observed in the magnesium sulphate group was 38.32 ± 9.33 years and in the dexmedetomidine group it was 39.82 ± 9.59 years, there was no significant difference in the mean age of the participants and thus both the groups stand comparable.

Table 2: Gender distribution

	Magnesium sulphate	**Dexmedetomidine**
Male	29 (58%)	27 (54%)
Female	21 (42%)	23 (46%)
Total	50 (100%)	50 (100%)
Chi square test = 0.16, p =0.68, Not statistically significant		

In the present study, 56% were male and 44% were female. There was no statistically significant difference in the gender distribution across the groups.

Table 3: Height in cm

	Magnesium sulphate	**Dexmedetomidine**
Mean Height in cm	159.34 ±7.15	160.18 ±3.16
T value = 0.76, p=0.44, Not statistically significant		

The mean height in the magnesium sulphate group was 159.34 ±7.15 cms, and in dexmedetomidine group it was 160.18 ±3.16.
No statistically significant difference in the mean height across the groups, thus both the group is comparable in term of height of the subjects.

Table 4: Weight in Kg

	Magnesium sulphate	**Dexmedetomidine**
Mean Weight in Kg	61.48 ±9.17	60.66 ±5.86
T value = 0.53, p=0.59, Not statistically significant		

The mean weight of the participants in the magnesium sulphate group was 61.48±9.17 kgs, and in the dexmedetomidine group it was 60.66 ±5.86 kgs.
No significant difference in the weights across the groups and thus they stand comparable in terms of weight of the participants.

Table 5: ASA Status

	Magnesium sulphate	**Dexmedetomidine**
ASA 1	37 (74%)	35 (70%)
ASA 2	13 (26%)	15 (30%)
Total	50 (100%)	50 (100%)
Chi square test = 0.19, p =0.65, Not statistically significant		

In the present study, in the magnesium sulphate group, 74% of the participants were in grade 1 ASA and 26% were under grade 2 ASA.
In the dexmedetomidine group, 70% of the participants were in ASA I and 30% were in ASA II. No significant difference in the ASA grading across the groups and both the groups stand comparable.

Table 6: Procedure

	Group		
Procedure	**Magnesium sulphate**	**Dexmedetomidine**	
UV Prolapse	0 (0.0%)	4 (8.0%)	4 (4.0%)
Appendicectomy	0 (0.0%)	2 (4.0)	2 (2.0%)
BAT	0 (0.0%)	5 (10.0)	5 (5.0%)
CRIF with ILN	4 (8.0%)	0 (0.0)	4 (4.0%)
Debridement	0 (0.0%)	3 (6.0)	3 (3.0%)
DHS	0 (0.0%)	1 (2.0)	1 (1.0%)
DUB	0 (0.0%)	2 (4.0)	2 (2.0%)
implant removal	9 (18.0%)	2 (4.0)	11.(11.0%)
Interval Appendicectomy	0 (0.0%)	2 (4.0)	2 (2.0%)
Jabolauys procedure	0 (0.0%)	2 (4.0)	2 (2.0%)
Laparotomy	0 (0.0%)	2 (4.0)	2 (2.0%)
mesh repair	8 (16.0%)	9 (18.0)	17.(17.0%)
Myomectomy	1 (2.0%)	2 (4.0)	3 (3.0%)
NDVH	0 (0.0%)	1 (2.0)	1 (1.0%)
open appendicectomy	6 (12.0%)	2 (4.0)	8 (8.0%)
ORIF	0 (0.0%)	2 (4.0)	2 (2.0%)
ORIF with buttress plate	2 (4.0%)	0 (0.0)	2 (2.0%)
ORIF with screw	2 (4.0%)	0 (0.0)	2 (2.0%)
Sequestrectomy	2 (4.0%)	0 (0.0)	2 (2.0%)
SSG	4 (8.0%)	2 (4.0)	6 (6.0%)
TAH	0 (0.0%)	4 (8.0)	4 (4.0%)
Trendelenberg procedure	6 (12.0%)	3 (6.0)	9 (9.0%)
Varicocoelectomy	2 (4.0%)	0 (0.0)	2 (2.0%)
VH	4 (8.0%)	0 (0.0)	4 (4.0%)

Table 7: Duration of surgery in min

	Magnesium sulphate	**Dexmedetomidine**
<50 min	25 (50%)	12 (24%)
51 – 100 min	25 (50%)	29 (58%)
>100 min	0 (0%)	9 (18%)
Total	50 (100%)	50 (100%)
Mean ±SD	49.16 ±24.73	72.10 ±24.32
Chi square test = 13.86, p=0.001*, Statistically significant		

The mean duration of surgery in magnesium sulphate group was 49.16 ±24.73 mins and in the dexmedetomidine group it was 72.10 ±24.32 mins. Statistically significant difference in the mean duration of surgery across the groups. The duration of surgery in the dexmedetomidine group was significantly higher in magnesium sulphate group.

Table 8: Heart rate

	Magnesium sulphate	Dexmedetomidine	P value
Baseline	90.26 ± 14.79	88.36 ± 12.40	0.48
2 min	95.38 ± 17.91	80.60 ± 16.54	0.001*
5 min	92.86 ± 18.69	82.08 ± 14.26	0.001*
10 min	90.00 ± 16.59	78.84 ± 11.79	0.001*
15 min	88.10 ± 15.12	76.84 ± 11.52	0.001*
20 min	87.72 ± 14.82	82.80 ± 14.86	0.05
25 min	84.22 ± 13.44	83.40 ± 14.45	0.38
30 min	84.92 ± 14.85	80.52 ± 15.33	0.07
35 min	88.24 ± 15.74	83.36 ± 14.06	0.05
40 min	84.44 ± 14.47	85.88 ± 15.67	0.32
45 min	84.96 ± 14.37	81.14 ± 15.21	0.10
50 min	85.32 ± 15.23	86.22 ± 14.58	0.38
55 min	81.82 ± 14.08	84.72 ± 15.02	0.16
60 min	85.60 ± 15.18	88.30 ± 14.15	0.18
70 min	87.64 ± 13.98	85.44 ± 13.48	0.21
80 min	85.92 ± 13.38	83.80 ± 15.13	0.23
90 min	88.30 ± 15.08	89.26 ± 15.90	0.38

Statistically significant difference in the mean heart rate from the baseline across the group from the start of 2 minute till 15 mins and the mean heart rate in the magnesium sulphate group were higher significantly when compared to the dexmedetomidine group.

Table 9: Systolic blood pressure

	Magnesium sulphate	Dexmedetomidine	P value
Baseline	131.5 ± 17.18	131.34 ± 11.86	0.95
2 min	131.56 ± 17.31	123.86 ± 14.16	0.01*
5 min	126.98 ± 19.19	122.24 ± 12.83	0.07
10 min	124.72 ± 18.45	117.2 ± 13.49	0.01*
15 min	123.62 ± 16.66	113.2 ± 15.13	0.001*
20 min	112.72 ± 14.35	111.7 ± 12.31	0.35
25 min	104.08 ± 23.11	104.82 ± 21.63	0.43
30 min	111.1 ± 10.23	109.72 ± 12.34	0.27
35 min	116.02 ± 4.152	112.76 ± 10.38	0.02*
40 min	113.16 ± 4.376	109.08 ± 9.332	0.001*
45 min	112.42 ± 13.92	111.12 ± 13.46	0.32
50 min	103.88 ± 22.70	103.4 ± 22.40	0.46
55 min	110.34 ± 9.813	109.92 ± 10.90	0.42
60 min	116.38 ± 3.901	116.86 ± 4.160	0.28
70 min	111.7 ± 9.315	112.26 ± 4.637	0.35
80 min	112.14 ± 10.17	116.86 ± 4.160	0.001*
90 min	110.88 ± 6.532	112.26 ± 4.637	0.11

No statistically significant difference in the SBP across the groups, the mean SBP in the dexmedetomidine group was significantly lower when compared to magnesium sulphate group.

Table 10: Diastolic blood pressure

	Magnesium sulphate	Dexmedetomidine	P value
Baseline	75.22 ± 18.10	76.74 ± 8.148	0.58
2 min	78.42 ± 9.682	73.58 ± 10.15	0.01*
5 min	76.54 ± 11.43	72.1 ± 9.116	0.02*
10 min	74.84 ± 10.41	69.62 ± 10.11	0.01*
15 min	75.64 ± 8.515	67.94 ± 9.885	0.001*
20 min	75.26 ± 9.218	69.04 ± 10.15	0.001*
25 min	73.78 ± 8.788	65.36 ± 8.838	0.001*
30 min	72.82 ± 7.795	67.74 ± 9.273	0.001*
35 min	71.92 ± 8.708	69.2 ± 8.609	0.06
40 min	70.6 ± 7.024	69.56 ± 10.14	0.28
45 min	70.9 ± 8.994	68 ± 9.595	0.06
50 min	70.82 ± 10.92	70.04 ± 9.576	0.35
55 min	72.82 ± 7.795	67.74 ± 9.273	0.001*
60 min	71.92 ± 8.708	69.2 ± 8.609	0.06
70 min	70.6 ± 7.024	69.56 ± 10.14	0.28
80 min	70.9 ± 8.994	68 ± 9.595	0.06
90 min	70.82 ± 10.92	70.04 ± 9.576	0.35

No statistically significant difference in the DBP across the groups, the mean DBP in the dexmedetomidine group was significantly lower when compared to magnesium sulphate group.

Table 11: Comparison of mean body temperature

	Magnesium sulphate	Dexmedetomidine
Mean body temperature	35.62 ± 0.14	35.95 ± 0.13
T test = 12.21, p=<0.0001*, Statistically significant		

The mean body temperature in the magnesium sulphate group was 35.62 ± 0.14 and in the dexmedetomidine it was 35.95 ± 0.13. There was a statistically significant difference in the mean temperature across the groups and the temperature was higher significantly in the dexmedetomidine group when compared to the magnesium sulphate group.

Table 12: Time interval for disappearance of shivering

	Magnesium sulphate	Dexmedetomidine
Time interval for disappearance of shivering	3.88 ± 0.25	2.18 ± 0.26
T test = 33.32, p=<0.0001*, Statistically significant		

The mean time taken for the disappearance of shivering in the magnesium sulphate group was 3.88 ± 0.25 mins and in the dexmedetomidine group it was 2.18 ± 0.26 mins. Statistically significant difference noted in the meantime taken for the disappearance of shivering across groups. The time take for disappearance of shivering in the dexmedetomidine group was significantly lower when compared to the magnesium sulphate group.

Table 13: Mean respiratory rate

	Magnesium sulphate	Dexmedetomidine
Mean Respiratory rate	23.96 ± 0.44	21.99 ± 0.21
T test = 28.57, p=<0.0001*, Statistically significant		

The mean respiratory rate in the magnesium sulphate 23.96 ± 0.44 and in the dexmedetomidine group it was 21.99 ± 0.21. There was a statistically significant difference in the mean respiratory rate across the groups. The mean respiratory rate in the dexmedetomidine group was lower than the magnesium sulphate group.

Table 14: Comparison of shivering score

	Magnesium sulphate	Dexmedetomidine
Shivering score	3 ± 0	3 ± 0

There was no statistically significant difference in the mean shivering scores across the group.

Table 15: Comparison of side effects

	Magnesium sulphate	Dexmedetomidine
Nausea	2 (4%)	2 (4%)
Nausea and sedation	1 (2%)	3 (6%)
None	47 (94%)	45 (90%)
Total	50 (100%)	50 (100%)
Chi square test = 1.04 , p=0.59 , Not statistically significant		

Here it was observed that most of the participants did not have complications. The occurrence of side effects across the groups was comparable and the most common side effect upon usage of these drugs being nausea and sedation.

Table 16: Recurrence of shivering

	Magnesium sulphate	Dexmedetomidine
Yes	1 (2%)	0 (0%)
No	49 (98%)	50 (100%)
Total	50 (100%)	50 (100%)
Chi square test = 1.0, p=0.31, Not statistically significant		

There was no statistically significant difference in the recurrence of shivering across the groups and the recurrence of shivering was seen only in 1 case in whom magnesium sulphate was given and none had shivering in dexmedetomidine group.

DISCUSSION

In 6% to 65% of patients, shivering during surgery is a frequent and painful consequence. Involuntary contractions of one or more muscle groups are referred to as shivering.[10,11] Shivering can also be brought on by other factors such pain, diminished sympathetic activity, unchecked spinal reflux, cytokine release, and adrenal suppression. However, the most frequent cause is impaired thermoregulation brought on by hypothermia brought on by a 0.5–1°C drop in core heat. Recent studies have looked at the role of dexmedetomidine in shivering, and further study is being done in this area. The FDA has cleared the use of

dexmedetomidine, an alpha-2 receptor agonist, for infusion up to 24 hours at a maximum dose of 0.7 g per kg body weight per minute. Alpha-2 agonists have been shown to have analgesic effects. To correlate the effectiveness, hemodynamic effects, and side effects of dexmedetomidine and magnesium sulphate in the treatment of intraoperative shivering.[11,12]

Intraoperative shivering has been prevented and treated with a variety of pharmaceutical and non-pharmacological strategies. Results that were mainly similar to those of the current investigation were published by Ebru Tarkç Klça et al. Dexmedetomidine did not, however, lessen the need for analgesics, they found. The fact that they utilised a lower dose of dexmedetomidine-0.2 g.kg-1.h-1-could explain their unexpected results.[12,13]

Santpur MU et al. reported a reduction in heart rate but not a substantial reduction in blood pressure after the infusion of dexmedetomidine. They may have used dexmedetomidine in a bolus then maintenance regimen, which is why they developed this bradycardia (1 g.kg-1 over 20 minutes followed by 0.5 g.kg-1.h-1).[13,14] Dexmedetomidine infusion resulted in hypotension and bradycardia in the study by Ebru Tarkç Klça et al., but had no appreciable impact on oxygen saturation. Despite using a lower dose of dexmedetomidine (0.2 g.kg-1.h-1) than the current trial, this was still the case (0.5 g.kg-1.h-1).

In a study, dexmedetomidine was given to elderly patients scheduled for total knee arthroplasty under spinal anaesthesia in order to assess the hemodynamic changes as well as the degree of sedation and analgesia. They recommended using a 0.4–0.8 g.kg-1.h-1 intravenous infusion dosage without a loading dose. Dexmedetomidine recipients needed fewer postoperative opioid doses, experienced an increase in analgesia duration of 3.5 hours, and no significant changes in blood pressure or oxygen saturation. The prevalence of bradycardia was higher in patients who had received dexmedetomidine. Dexmedetomidine should be administered as a low dose regimen of continuous intravenous infusion rather than a big bolus dose, it seems, in order to prevent any potential unfavourable hemodynamic consequences.[14,15]

Patients undergoing surgery received intravenous MgSO4 boluses of 50 mg/kg before the procedure and 15 mg/kg/hr while under spinal anaesthesia, according to Akansha Agrawal et al. No serious side effects, such as hypotension, bradycardia, nausea, vomiting, or significant oxygen deficit, were noted by the patients.[15]

Similar to this, Prerana N. Shah et colleagues administered 500 mg intravenous infusions after 250 mg intravenous bolus doses of MgSO4 during spinal anaesthesia. Additionally, they did not note any MgSO4 bolus administration-related major hemodynamic side effects.[15,16]

Dexmedetomidine and MgSO4 did not have any notable negative effects in this trial, such as hypotension, bradycardia, and peripheral oxygen deprivation, nausea, vomiting, or shivering.

Bicer et al. found that dexmedetomidine administration was connected to 6 incidences of shivering (15%) while under general anaesthesia, compared to a rate of 55% in the control group.[16]

Rahimzadeh et al. found that dexmedetomidine reduced intraoperative haemorrhage and postoperative pain scores in individuals having spine surgery. Dexmedetomidine produced superior hemodynamic outcomes for the patients.[17]

According to Bajwa et al., 5% of patients receiving an intravenous dexmedetomidine injection (1 mg/kg) while under general anaesthesia shivered, compared to 42.5 percent of patients in the control group. This difference was statistically significant.[17,18]

In a research by Karaman et al., laparoscopic women who received an intravenous injection of dexmedetomidine (1 mg/kg) experienced significantly less shivering than those who received a placebo, with reductions of 10% and 46.7 percent, respectively.[18]

According to Moaward et al., shivering was observed in patients scheduled for prostatectomy by TURP at a rate of 15% in the dexmedetomidine group and 57% in the control group.[18,19]

The incidence of shivering decreased from 36.7 in the control group to 36°C in the Doufas et al. Dexmedetomidine participants' body temperatures did hit 35.5 degrees, though. This theory is supported by the fact that it did not differ noticeably from the control group and that shivering was much less common. Dexmedetomidine's ability to prevent vasospasm and the action of an alpha-2 agonist may also function as additional mechanisms to prevent shivering.[19]

When compared to the control group, the dexmedetomidine group in a study by Bajwa et al. (2012) demonstrated a protective effect against nausea, vomiting, and headache.[20]

Usta et al. (2011) found no difference in the incidence of allergic reaction, hypotension, nausea, vomiting, headaches, or urine impairment depending on whether dexmedetomidine was administered.[20,21] Dexmedetomidine injection during spinal anaesthesia for TURP surgery did not substantially differ from the control group in terms of nausea and vomiting, but it was related with hypotension and bradycardia when compared to the placebo group (20.5% vs. 5% and 15% vs. 2.5%). Since intravenous magnesium sulphate has previously been observed to inhibit post-anaesthetic shivering, Wadhwa and colleagues hypothesised that intravenous magnesium sulphate infusion lowers the shivering threshold in humans.[21]

CONCLUSION

Dexmedetomidine 1mcg/kg and magnesium sulphate 50mg/kg, in combination, effectively reduced intraoperative shivering. Dexmedetomidine required the shortest amount of time to stop the shivering, and it also meant that the body temperature was greater and the heart rates were kept at lower levels. Another option is to use magnesium sulphate.

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