Original Article

Evaluation of the Efficacy of Dexamethasone Versus Magnesium Sulfate in Prevention of Postspinal Shivering: A Prospective, Randomized, Double-Blind Study

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Abstract

Background: Postspinal shivering represents one of the distressing complications of regional anesthesia. This study evaluated the efficacy of dexamethasone and magnesium sulfate to prevent postspinal shivering (PSAS) in lower abdominal and lower limb surgeries.

Materials and Methods: Hundred forty-seven patients undergoing elective abdominal and lower limb surgery under spinal anesthesia received either 100 mL isotonic saline (group C), 8 mg in 100 mL isotonic saline (group D), or magnesium sulfate 30 mg/kg in 100 mL isotonic saline (Group M).

Results: The incidence of clinically significant shivering was highly significantly less in group D and group M compared to group C (p=0.001), however, there was no statistically significant difference between group D and group M (p=0.052). The onset of shivering was significantly lower in the C group compared to the D and M groups with statistically significant differences between the D and M groups (p=0.001).

Conclusion: Dexamethasone and magnesium sulfate were effective in the prevention of PSAS in patients undergoing lower abdominal and lower limb surgeries under spinal anesthesia. However, magnesium sulfate is better than dexamethasone as it is accompanied by less incidence of shivering, and its sedative effect decreases the stress of the surgery.

Keywords: Postspinal shivering, Spinal anesthesia, Dexamethasone, Magnesium sulfate

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Introduction

Postspinal shivering (PSAS) represents one of the distressing complications of regional anesthesia. Although many pharmacological agents have been used to prevent or treat PSAS, the ideal treatment was not found (1). This study evaluated the efficacy of dexamethasone and magnesium sulfate to prevent PSAS in patients undergoing lower abdominal and lower limb surgeries.

Methods

This prospective double-blinded randomized control trial was conducted at Menoufia University hospitals after obtaining approval from its ethics committee (IRB approval number 4\ 2022 ANET1-1) and registered at www.pactr.org (PACTR 202203695753410). This trial was prepared in concordance with the Consolidated Standards of

Reporting Trials (CONSORT) guideline. Informed written consent was obtained from all eligible patients.

One hundred forty-seven patients aged between 20 and 60 years old of both sexes with the ASA class I or II undergoing elective lower abdominal and lower limb surgery under spinal anesthesia (SA). Patients on central nervous system depressants, or with physical dependence on opioids, hepatic or renal disease, pregnancy or lactation, and diabetes mellitus were not included. We also excluded patients refusing or having a contraindication for neuraxial blocks, a history of hypersensitivity to one of the drugs, or were not willing to participate in the study.

Eligible patients fulfilling all inclusion criteria and no exclusion criteria were randomized 1:1:1 using a computerized software program (GraphPad software QuickCalcs, Inc.California, USA. website: http://www.graphpad.com/quickcalcs/ index. cfm). The allocation was masked for the participants, the clinical staff, the trial investigators, and the trial statistician who conducted the analyses. The entire drug preparation and administration was performed by an anesthesiologist who was not involved in the study.

All patients were premedicated with bromazepam (1.5 mg) the night before surgery and 2 hours before the call to the operative theatre. On arrival in the operating room, standard monitoring was applied and the operating and recovery room temperatures were maintained at 23–25°C (measured by a wall thermometer) with approximately 60–70% humidity. An 18-gauge cannula was inserted in a peripheral vein, and a lactated ringer infusion (at room temperature) at 10 ml/kg within 30 min then (7 ml⁄kg⁄hr) was started. All patients were premedicated with intravenous (IV) glycopyrrolate (0.004 mg⁄kg) and midazolam (0.03 mg⁄kg).

Following the rules for asepsis and antisepsis, SA was instituted at either the L3–4 or L4–5 interspaces (midline approach) with the patient in a sitting posture. A volume of (2.5–3.5 ml) (12.5-17.5 mg) of hyperbaric bupivacaine was injected over 60 seconds using a 25 G Quincke spinal needle to achieve a desirable level per the surgical procedure. If patients didn't develop complete sensory and motor blockade, general anesthesia was administered and those were excluded from the study.

After completion of the subarachnoid injection, the patients were randomly allocated to Group C (control group) received 100 mL isotonic saline, Group D (dexamethasone group) received 8 mg in 100 mL isotonic saline while those belonging to Group M (magnesium sulfate group) received magnesium sulfate 30 mg/kg in 100 mL isotonic saline.

The incidence and severity of shivering were recorded during the operation till 90 min after SA. Shivering severity was assessed with a four-point scale (2):

1. None (Grade 0): no shivering noted on palpation of the masseter, neck, or chest wall
2. Mild (Grade 1): shivering localized to the neck and/or thorax.
3. Moderate (Grade 2): shivering involves the gross movement of the upper extremities (in addition to the neck and thorax)
4. Severe (Grade 3): shivering involved gross movements of the trunk and upper and lower extremities.

If the shivering grade is ≥2 after completion of the subarachnoid injection, 25 mg meperidine IV (diluted to 10 mL with NS) was slowly injected as a rescue agent.

Changes produced in heart rate (HR), and mean arterial pressure (MAP) were recorded at prespinal, 2, 5,10, 15, 20,30, 45, 60, 75, and 90 min after intrathecal injection. Side effects like hypotension (MAP < 20% from baseline), bradycardia (HR < 50 beats/min), respiratory depression (respiratory rate≤8/min or SPO2≤92%), nausea, and vomiting were recorded. Sedation was assessed using sedation score as (awake and alert=0, quietly awake=1, asleep but easily aroused=2, deeply asleep=3) (3).

The primary outcome was the incidence of clinically significant PSAS which required IV pethidine for treatment (Grade 2 (moderate) and Grade 3 (severe)) during the first 90 min (the end point of the study) after the completion of the subarachnoid drug injection (start point of the study). The shivering onset, hemodynamic changes, incidences of complications, and sedation were the secondary outcomes.

Statistical analysis: The sample size was estimated using the incidence of clinically significant postspinal shivering between the three groups as the main primary variable. Based on a previous study by Esmat et al (4).

The power of the study is 80% and the confidence level is 95%.

Data were collected, tabulated, and statistically analyzed using an IBM personal computer with Statistical Package of Social Science (SPSS) version 20 (SPSS, Inc, Chicago, Illinois, USA). Quantitative data were presented in the form of mean, standard deviation (SD), range, and qualitative data were presented in the form of numbers and percentages. The Chi-square test (χ^2) was used to study the association between two qualitative variables. Kruskal Wallis (K) was used for comparison between three groups not normally distributed having quantitative variables P-value of <0.05 was considered statistically significant.

Ethical approval: Menoufia University Faculty of Medicine Research Ethics Committee; IRB approval number and date 4\ 2022 ANET1-1.

Trial registration: www.pactr.org (PACTR 202203695753410); Date of Registration 24-2-2022; First Patient Enrollment Date.4-4-2022.

Results

One hundred forty-seven patients were included in the study without dropout. There were no significant differences between the study groups regarding demographic characteristics and/or surgery duration (p>0.05).

The incidence of clinically significant shivering (shivering grade≥2) was significantly less in group D and group M compared to group C (p=0.001), however, there was no statistically significant difference between group D and group M (p=0.052). The onset of shivering was significantly higher in the M group compared to C and D groups (p=0.001).

The hemodynamic parameter (HR, MAP) were comparable between the three studied groups (p>0.05) (Figure 1**).** There was no significant difference regarding bradycardia and hypotension among the study groups (p>0.05).

Pruritus was recorded in (20.4 % vs 12.2% vs 4.10%) in groups C, D, and M respectively (p= 0.048), also nausea and vomiting were significantly higher in group C compared to group D and group M (p=0.027). no other side effects were recorded. The sedation score was significantly higher in Group M when compared to Group D and Group C (p=0.001).

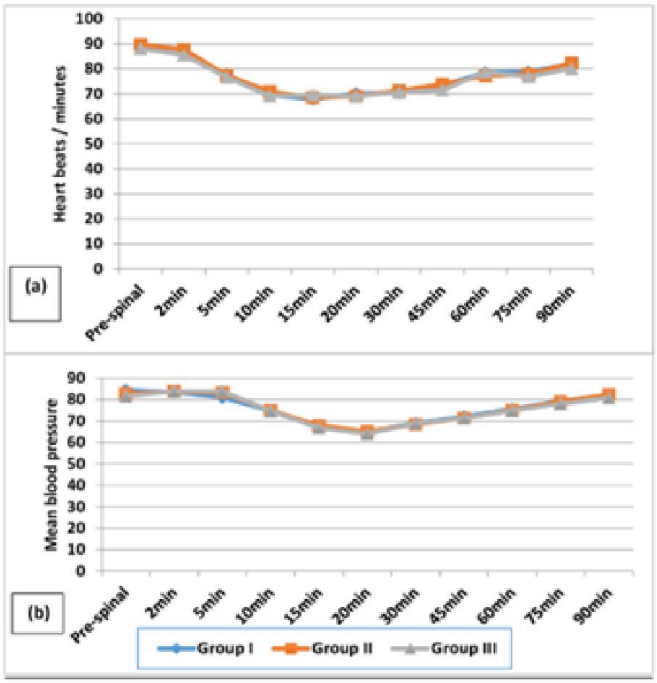

Figure 1. Hemodynamic changes over time among the studied groups, (a): Mean heart rates, (b): Mean blood pressure.

Table 1: demographic data, shivering profile, and complications among the studied groups (N=147).

Studied variables	Group C (N=49)	Group D (N=49)	Group M (N=49)	Test of sig	P value
Age/years				K	
Mean ±SD	39.8±13.3	38.4±12.8	39.1±13.5		
Median(IQR)	40.0(27.5 –50.0)	36.0(27.5 -50.0)	39.0(26.5 – 51.0)	0.208	0.901
Sex N (%)				χ^2	
Male	27(55.1)	25(51.0)	26(23.1)		0.921
Female	22(44.9)	24(49.0)	23(46.9)	0.164	
BMI				K	
Mean ±SD	25.8±0.96	25.9±0.94	25.6±0.92	2.40	0.300
Median(IQR)	26.0 (25.0 – 26.5)	25.8(25.0–26.9)	25.7(25.7 – 26.3)		
ASA N (%)				χ^2	
I	25(51.0)	27(55.1)	24(49.0)		0.826
II	24(49.0)	22(44.9)	25(51.0)	0.381	
Duration of surgery					
Mean ±SD	96.5±21.6	95.9±21.4	97.5±22.9	K	
Median(IQR)	90.0 (80.0 – 117.5)	90.0(80.0– 115.0)	100(80.0– 120.0)	0.157	0.925
Type of surgery				χ^2	
General surgery	27(55.1)	26(53.1)	25(51.0)		
Gynecology	6(12.2)	7(14.3)	10(20.4)	1.55	0.956
Orthopedic	9(18.4)	8(16.3)	7(14.3)		
Urology	7(14.3)	8(16.3)	7(14.3)		
Incidence of shivering	44 (89.8)	28 (57.1)	16 (32.7)	χ^2 33.5	**0.001****	**P1:0.001**** **P2:0.001**** **P3:0.014***
Shivering grades				χ^2		**P1:0.001****
0	5(10.2)	21(42.9)	33(67.3)			**P2:0.001****
I	7(14.3)	13(26.5)	9(18.4)		**0.001****	
II	24(49.0)	9(18.4)	5(10.2)	46.6		P3:0.088
III	13(26.5)	6(12.2)	2(4.10)			
Grade				χ^2		**P1:0.001****
(0+ I)	12(24.5)	34(69.4)	42(58.7)		**0.001****	**P2:0.001***

Grade				41.0		*
(II+ III)	37(75.5)	15(30.6)	7(14.3)			P3:0.052
Shivering onset				K		**P1:0.001***
Mean ±SD	15.5±1.97	36.7±1.93	77.5±2.18	73.3	**0.001****	
Median(IQR)	15.0(15.0-17.0)	36.5(35.0 – 37.7)	77.5(75.0–80.0)			**P2:0.001***
						P3:0.001*
Hypotension				K		
Yes	13(26.5)	6(12.2)	8(16.3)			
No	36(73.5)	43(87.8)	41(83.7)	3.53	0.170	
Bradycardia				K		
Yes	7(14.3)	3(6.10)	5(10.2)			
No	42(85.7)	46(93.9)	44(89.8)	1.78	0.410	
Pruritis				K		
Yes	10(20.4)	6(12.2)	2(4.10)	6.07	**0.048***	
No	39(79.6)	43(87.8)	47(95.9)			
Nausea and vomiting				K		
Yes	11(22.4)	3(6.10)	4(8.20)	7.21	**0.027***	
No	38(77.6)	46(93.9)	45(91.8)			
Sedation score				χ^2		
0	32(65.3)	18(36.7)	6(12.2)			
1	17(34.7)	31(63.3)	16(32.7)	78.7	**0.001****	
2	0(0.00)	0(0.00)	27(55.1)			

Discussion

This study demonstrated clinically and statistically significant superiority of both a prophylactic dose of IVI dexamethasone and magnesium sulfate as regards the clinically significant shivering compared to the control group. However, magnesium sulfate is better than dexamethasone as it is accompanied by less incidence of shivering and its sedative effect decreases the stress of the surgery without respiratory depression.

The strength of this study is being an RCT, and comparing, for the first time, the anti-shivering efficacy of magnesium sulfate and dexamethasone also, the cost-effective management protocol for PSAS that could be easily applied in resource-limited areas. The study is, however, limited by the relatively small sample size. Larger multi-centric studies are recommended to attain a firm conclusion. Also, this study lacked core temperature measurement.

In our study, both magnesium sulfate and dexamethasone decrease the incidence and severity of clinically significant shivering and delay the onset of shivering. This can be explained depending on that dexamethasone, a synthetic adreno-corticosteroid with glucocorticoid activity can reduce the incidence and the severity of PSAS by decreasing the core-body temperature gradient through its anti-inflammatory action and inhibiting the release of pyogenic cytokines and vasoconstrictors (5). On the other hand, magnesium has both central and peripheral effects. The central effect through blocking of N-methyl-D

aspartate (NMDA) receptors leads to a decrease in norepinephrine, and serotonin and both have a role in thermoregulatory control and decrease the shivering threshold. Also, it causes peripheral vasodilatation and improves cutaneous circulation. Besides its central effect, it causes peripheral muscle relaxation effect via calcium antagonist, thereby reducing the gain of shivering (incremental shivering intensity with progressing hypothermia) (6).

Consistent with our results, a study was done by Entezariasl et al., (7) which proved the anti-shivering effect of dexamethasone. Moreover, it has also been shown to be superior to pethidine as a standard anti-shivering drug. Also, a meta-analysis was done by Kawakamia et al., (8) about the efficacy of magnesium in the prevention of postanesthesia shivering. They concluded that perioperative administration of intravenous magnesium decreases the incidence and severity of shivering.

In our study, the use of magnesium sulfate produces adequate sedation scores without any episodes of respiratory depression. The sedative effect of magnesium sulfate was agreed upon by Memis D et al (9). This is due to the inhibitory effect of magnesium sulfate on NMDA receptors which inhibit calcium entry and neurotransmitter release (10). Surprisingly enough, this feature was reported by most of our patients to be the most satisfying point. They reported that they wished to be not vigilant during the surgery.

Conclusion

Dexamethasone and magnesium sulfate were effective in the prevention of PSAS in patients undergoing lower abdominal and lower limb surgeries under spinal anesthesia. However, magnesium sulfate is better than dexamethasone as it is accompanied by less incidence of shivering, and its sedative effect decreases the stress of the surgery

Acknowledgment

None.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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