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Research Article

Prophylactic vs. therapeutic magnesium sulfate for shivering during spinal anesthesia

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KEYWORDS

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Abstract *Introduction:* Shivering is one of the most common complications of neuraxial blockade. Some patients find shivering sensation worse than surgical pain. Therefore, both prevention and treatment of established shivering should be regarded as clinically relevant intervention in the perioperative period. The aim of our study is to compare the efficacy of magnesium sulfate when used for prevention or treatment of shivering following spinal anesthesia.

Methods: In this prospective, double blind, placebo controlled study, 120 ASA I, II patients undergoing surgery under spinal anesthesia were randomized into 3 groups. Following intrathecal injection, Group P (prophylactic) was given $MgSO_4$, 50 mg/kg I.V. bolus + 2 mg/kg/h infusion. Group T (therapeutic) was given $MgSO_4$ 50 mg/kg I.V. bolus as a therapy when shivering occurred. If shivering persisted, they received 25 mg/kg I.V. bolus. Group C (control) received saline at identical times. Meperidine was given as rescue if shivering persisted. Shivering grade 3/4 was regarded as significant. Core temperatures, incidence of shivering, and side effects were recorded.

Main results: Total incidence of shivering, grade 3/4, was 15% in Group P, 45% in Group T, and 50% in Group C ($p < 0.01$). Magnesium sulfate significantly reduced the incidence and gain of shivering. The use of rescue meperidine was more in Group P (20%) and Group C (50%) compared to none in Group T ($p < 0.05$, $p < 0.01$, respectively). Significant reduction in core temperature occurred in the Mg groups compared to the control group $p < 0.05$. No correlation was found between patients who shivered and core temperature or ΔT. Hypotension was more frequent in Group P; nausea and vomiting were more in Mg groups than control group $p < 0.05$.

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Conclusion: Following spinal anesthesia, prophylactic $MgSO_4$ infusion lowered incidence of shivering. When shivering did occur, $MgSO_4$ proved to be an effective treatment with minimal side effects.

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1. Introduction

Shivering is a frequent complication following neuraxial anesthesia. It is an involuntary, oscillatory muscular activity that augments metabolic heat production. Shivering may occur as a response to hypothermia. However, it may also occur in normothermic patients [1].

Regional anesthesia impairs both central and peripheral thermoregulatory control. In patients becoming sufficiently hypothermic, shivering may appear and is often disturbing to both patients and medical staff [2]. Shivering may interfere with monitoring of heart rate, blood pressure, and oxygen saturation. It is associated with substantial adrenergic activation [3]. It increases oxygen consumption, lactic acidosis, carbon dioxide production, and metabolic rate by up to 400%; thus, it may cause problems in patients with low cardiac and pulmonary reserves [1].

Numerous studies have tested the efficacy of a large variety of interventions to prevent shivering in normothermic or hypothermic surgical patients, but the relative efficacy of these interventions, however, remains unclear [4].

As the incidence of hypotension is high during regional anesthesia, hypotensive agents including clonidine and urapidil may not be appropriate in preventing shivering. In addition, meperidine (the most widely used agent) and tramadol may cause nausea and vomiting and respiratory depression during and after regional anesthesia. The hypertensive and tachycardiac effects of ketamine limits its use [5].

The search continues for drugs that sufficiently improve thermoregulatory tolerance without simultaneously producing excessive sedation or respiratory depression.

Intravenous magnesium has been shown to suppress postoperative shivering suggesting that the agent reduces the shivering threshold [6]. Recently, the addition of intravenous magnesium sulfate to a pharmacological antishivering regimen increased the cooling rate in unanesthetized volunteers [7]. The drug not only exerts a central effect [8] but is also a mild muscle relaxant [9] and may thus simultaneously reduce the gain of shivering (incremental shivering intensity with progressing hypothermia) [10].

This study was designed to compare the effectiveness of magnesium sulfate when given prophylactically to that given as treatment in the control of shivering.

2. Patients and methods

This randomized, double blind, placebo controlled study was carried out at the anesthesiology department in El-Minia University Hospital. We included 120 male and female patients, 18–60 years of age scheduled to undergo elective lower extraperitoneal abdominal or lower limb surgery using spinal anesthesia. Patients with ASA physical status > II, severe cardiopulmonary disease, renal or liver impairment, preoperative fever, history of seizures or peripheral neurological disease, contraindication to regional anesthesia, thyroid disease, parkinsonism, Raynaud's syndrome, allergy to the study medications, massive blood transfusion during surgery and those receiving vasodilators or medications that alter thermoregulation were excluded from the study.

The study was double blind (neither the investigator nor the patients knew the nature of the drugs given), and the unknown solutions were prepared and supplied to the investigator in 25 ml ampoules and coded as (A, B, C and D) for IV injection and infusion. The protocol was opened after the study was completed.

Randomization was done according to computer generated number.

The study drugs were administered as follows:

- 0.5 ml / kg was taken from ampoule A, diluted in 60 ml glucose 5% and injected IV over 10 min immediately after spinal injection.
- This is followed by 2 ml taken from ampoule B, diluted in 200 ml and given IV at a rate of 2 ml/kg/h.
- If shivering occurs, 0.5 ml/kg was taken from ampoule C, diluted in 60 ml glucose 5%, and injected IV over 10 min.
- If shivering continues, 0.25 ml/kg was taken from ampoule D, diluted to 60 ml glucose 5%, and injected IV over 10 min.
- If shivering persists, meperidine 25 mg was injected IV.

Drugs used in the study were the following: magnesium sulfate ampoule 25 ml 10%, 100 mg/ ml (Egypt Otsuka pharm. Co.); saline 0.9% ampoule 25 ml (Egypt Otsuka pharm. Co.); and meperidine (Pethidine) 50 mg/ml.

The patients admitted were blindly injected and classified into 3 equal groups (40 patients each), group P (Prophylactic group), received $MgSO_4$ 50 mg/kg IV bolus + 2 mg/kg/h infusion as prophylaxis (A and B ampoules were $MgSO_4$ and C and D ampoules were saline), Group T (Therapeutic group): received $MgSO_4$ 50 mg/kg IV bolus as therapy when shivering occurred, and if shivering persists, they received 25 mg/kg IV bolus of $MgSO_4$ (A and B ampoules were saline; C and D ampoules were $MgSO_4$) and group C (Control group) received 0.9% saline for injection as a placebo (A, B, C, and D ampoules were saline). In all groups if shivering of grade 3 or more persists, meperidine 25 mg IV was given as a rescue drug.

No premedication was given. In the operating room, after IV access, all patients received 500 cc lactated Ringer's solution maintained at room temperature. The ambient temperature was maintained at 22–24 °C.

Spinal anesthesia was performed at either L3/4 or L4/5 interspaces. Hyperbaric bupivacaine, 20 mg was injected using a 24 gauge spinal needle with the patients in the lateral decubitus position. Level of sensory blockade was assessed by pinprick and motor blockade by Bromage scale [11].

Supplemental oxygen was delivered via a nasal cannula (4 L/min) if needed. Intraoperatively, all patients were monitored and covered by one layer of surgical drapes.

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