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Original Research Article

Effect of Intravenous Magnesium Sulphate for Prevention of Postoperative Pain in Infraumbilical Surgeries under Subarachnoid Block

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Abstract:

Background: In this study, we conducted a randomized, double-blind, prospective investigation to assess the impact of intravenous administration of magnesium sulphate at two distinct dosage levels on spinal anaesthesia, postoperative pain relief, and postoperative analgesic needs in individuals having infraumbilical surgeries.

Aims and Objectives: This study aims to conduct a comparative assessment of the efficacy of two different dosages of intravenous magnesium sulphate in preventing postoperative pain following infraumbilical operations performed under spinal anaesthesia.

Materials and Methods: Ninety female patients, classified as ASA grade I and II, aged between 20 and 40 years, who were scheduled for infraumbilical procedures (specifically lower segment caesarean section) under spinal anaesthesia, were chosen following a pre-anesthetic evaluation to ensure their physical suitability for the procedure. The patients were randomly assigned to three groups: group MS, group MS-30, and group MS-50, each consisting of 30 patients. The interventions involved administering 100 ml of 0.9% Normal saline, 30 mg kg-1 of Magnesium sulphate in 100 ml of 0.9% Normal saline, and 50 mg kg-1 of Magnesium sulphate in 100 ml of 0.9% Normal saline, respectively. These interventions were administered over a period of 15 minutes, 60 minutes after the administration of spinal anaesthesia. Following the surgical procedure, the patients were administered intravenous rescue analgesia in the form of an injection of Tramadol 100 mg. The study assessed postoperative pain ratings, rescue analgesic consumption, and the occurrence of several adverse events such as nausea, vomiting, dysnoea, respiratory depression, chest discomfort, drowsiness, shivering, dysrhythmia, bradycardia, and hypotension. These assessments were conducted immediately after surgery, as well as after 30 minutes, 1-, 2-, and 3-hours post-surgery. The findings were presented in terms of the mean and standard deviation. A p-value less than 0.05 were deemed to be statistically significant.

Results: Intravenous administration of magnesium sulphate at a dosage of 50 mg/kg under spinal anaesthesia resulted in a notable extension of the duration of analgesia, a higher quality of analgesia as shown by a lower Visual Analogue Scale (VAS) score, and a considerable decrease in the amount of postoperative analgesics required, as compared to the administration of a lower dose of 30 mg kg-1.

There were no notable occurrences of hemodynamic and respiratory instability seen following the administration of two doses of Magnesium sulphate.

Conclusion: The administration of intravenous magnesium sulphate during spinal anaesthesia has been found to enhance postoperative analgesia without notable adverse effects.

Keywords: Infraumbilical surgeries; Magnesium sulphate; Postoperative analgesia; Subarachnoid block.

Introduction

The utilization of spinal anaesthesia with lignocaine heavy is known to offer prompt analgesia and effective muscle relaxation during brief surgical operations. This technique is favored due to its predictable onset, dense sensory and motor blockage; however, it is associated with a significantly shorter duration of postoperative pain relief. [1] The surgical stress response reaches its highest point during the postoperative phase and has significant adverse impacts on several

physiological systems within the body. [2] Pre-emptive analgesia has been shown to significantly reduce neuro-humoral stress responses before surgical procedures. The objectives of pre-emptive analgesia encompass the reduction of postoperative pain and the prevention of chronic pain. Ensuring a painless postoperative phase is of utmost importance, as it serves to mitigate both morbidity and mortality rates. [1]

Magnesium ions (Mg++) exhibit anti-nociceptive properties by virtue of their antagonistic interaction with the N-methyl-D-aspartate (NMDA) receptor. Multiple clinical research have provided evidence that the infusion of magnesium ions (Mg++) during general anaesthesia leads to a decrease in the amount of anaesthetic required and the consumption of postoperative analgesics. However, a limited number of studies have indicated that the administration of magnesium ions (Mg++) during the perioperative period has minimal impact on postoperative pain.[3] There has been a limited number of research undertaken thus far to assess the impact of administering magnesium sulphate during regional anaesthesia in order to enhance postoperative pain relief. [4,5]

Aims and Objectives

The objective of this study was to assess the efficacy of intravenous magnesium sulphate at two distinct dosages for the prevention of postoperative pain following infraumbilical operations performed under spinal anaesthesia.

Materials and Methods

A double-blind randomized controlled trial was conducted on a sample of 90 female patients classified as ASA grade I and II, aged between 20 and 40 years. These patients were scheduled for infraumbilical operations under spinal anaesthesia. The study received clearance from the hospital ethics council (125-140/Bio/Ethical/MC).

Exclusion Criteria

- contraindication to spinal anaesthesia,
- a known history of allergy or sensitivity to local anesthetics of the amide type,
- patients with impaired renal or hepatic function, patients with varying degrees of heart blocks, hypertension, diabetes mellitus, and drug or alcohol abuse,
- patients with neurological disorders or myopathies,
- obese patients with a body mass index >30 kg/m2,
- patients on treatment with calcium channel blockers or magnesium,
- Patients with poor compliance with the study procedure.

The procedural details were thoroughly discussed to all patients at the pre-anesthetic check-up, and informed consent was acquired.

The preoperative patient characteristics, hemodynamic parameters, and drug-related adverse effects have been evaluated and documented. The participants were allocated into three groups using the sealed envelope method, which involved an arbitrary allocation process. The preloading procedure was the administration of 500ml of Ringer's lactate solution through an 18 G Cannula, which was initiated half an hour before to the induction of anaesthesia. Additionally, standard non-invasive measurements such as blood pressure, ECG, and pulse oximetry were performed.

The administration of spinal anaesthesia was achieved by injecting 1.4 ml of 5% hyperbaric Lignocaine into the L3-L4 intervertebral area. This procedure was performed with the patient positioned in the lateral decubitus position, using a 25-gauge Quinckes spinal needle. Subsequently, the individuals were positioned in a supine posture in preparation for the surgical procedure. In order to maintain hemodynamic stability throughout the perioperative period, the administration of crystalloids, colloids, and blood products was performed as needed.

Following 60 minutes of administering spinal anaesthetic, the participants were divided into three groups: Group NS, Group MS-30, and Group MS-50. Group NS got 100 mL of 0.9% Normal saline, Group MS-30 received 30 mg/kg in 100 mL of 0.9% NS, and Group MS-50 received 50 mg/kg in 100 mL of 0.9% NS, all administered over a period of 15 minutes. Upon the onset of the patient's pain experience, a prescription for iv administration of Tramadol 100mg was initiated. The vital parameters were continuously monitored during both the intraoperative and postoperative periods until the patient requested rescue analgesia in the postoperative phase. Continuous data monitoring was conducted, however for the purpose of statistical analysis, data points were recorded at certain time intervals following intrathecal injection: 0, 5, 10, 15, 30, and 60 minutes. Subsequently, data values were recorded every hour until the patient reported discomfort and requested analgesia. The study also included the assessment of many parameters, such as the onset time of sensory blockade, the highest level of sensory block, the time of onset of pain, the Visual Analogue Scale (VAS) score at the onset of pain, the duration of analgesia (pain alleviation), and the time for the need of rescue analgesia.

The evaluation of pain was conducted using the visual analogue scale (VAS). The pain distress scale is a numerical scale ranging from 0 to 10. The

assessment of sedation is conducted using the Ramsay sedation score.

During the intraoperative and postoperative periods, patients were thoroughly monitored for potential problems, such as nausea, vomiting, dyspnoea, respiratory depression, chest discomfort, drowsiness, shivering, dysrhythmia, bradycardia, hypotension, and any other adverse events.

Statistical Analysis

The findings were presented in terms of the mean and standard deviation. The data were subjected to different statistical analysis tests as appropriate for comparison. A p-value less than 0.05 were deemed to be statistically significant.

Results

Demographic Data: The age, weight, height and duration of surgery were comparable in both groups. (Table 1).

Table 1: Demographic data

Variables	Group NS (Mean±SD)	Group MS-30 (Mean±SD)	Group MS-50 (Mean±SD)	P-value
Age (in years)	25 + 3.67	26.16 + 3.88	25.93 + 3.18	>0.05 (NS)
Weight (in Kg)	51.83 ± 3.70	50.5 + 4.56	51.36 + 4.29	

NS- Not Significant (p>0.05)

There were no instances of technical failure associated with spinal anaesthesia, and the surgical procedures were carried out smoothly without any complications. The three groups exhibited similarities in several aspects, including the onset time of sensory block, the duration required to attain the highest level of sensory blockade, and the average time for rescue analgesia. (Table 2)

Table 2: Spinal characteristics

Parameters		Group NS (Mean±SD)	Group MS-30 (Mean±SD)	Group MS-50 (Mean±SD)	P-value
Onset time of Sensory blockade (minutes)		1.56 ± 0.56	1.33 ± 0.54	1.33 ± 0.48	>0.05 (NS)
Time taken to reach highest level(min)		3.94 ± 1.14	4.1 ±1.06	3.83 ± 1.05	
Highest level of sensory block	T_4 (n)	16	18	17	
	T_6 (n)	14	12	13	

NS- Significant (p>0.05)

The time of rescue analgesia I (TRA I) was administered showed no statistically significant differences among the three groups. In addition, it was observed that Group MS-50 exhibited a substantial increase in the time of rescue analgesia II (TRA II) and the overall duration of analgesia, in comparison to Group MS-30 and Group NS (P=0.001). The postoperative severity of pain was evaluated using the Visual Analogue Scale (VAS) at the commencement of discomfort. The MS-50 group had a higher level of analgesia, as shown by a significantly lower VAS score compared to both the MS-30 and NS groups (P=0.001). (Table 3)

Table 3: Time of rescue analgesia (TRA)

Parameters	Group NS (Mean±SD)	Group MS-30 (Mean±SD)	Group MS-50 (Mean±SD)	P-value
Time of rescue analgesia-I (min)	84.33 ± 11.19	82.83 ± 10.93	81.33 ± 9.64	>0.05 (NS)
Time of rescue analgesia-II (min)	367 ± 59.31	783 ± 147.04	922.83 ± 217.23	0.001 (S)
Total duration of analgesia	282.33 ± 59.31	700.16 ± 147.41	841.83 ± 217.10	0.001 (S)

NS- Not Significant (p>0.05), S- Significant (p<0.05)

The haemodynamic measures, including heart rate, systolic and diastolic blood pressure, respiratory rate, and Spo2, were found to be comparable between the magnesium group and the control group. No instances of postoperative haemodynamic or respiratory instability were seen during the duration of the trial. While no significant adverse effects or complications were detected in the present study, there were instances of nausea and vomiting (10%) and shivering (10%) in the NS group. In the MS-30 group, there were two cases of nausea and vomiting (6.6%) and one case of shivering (3.33%). Similarly, the MS-50 group experienced one case each of nausea and vomiting (3.33%) and shivering (3.33%). It is worth noting that these occurrences were comparable across all groups. Significant complaints of discomfort at the infusion site were reported by all patients in both magnesium groups, in comparison to the NS group.

Discussion

Regional anaesthesia is a cost-effective and secure method that offers the added benefit of extended postoperative analgesia. The successful management of postoperative pain mitigates autonomic, somatic, and endocrine responses. The use of a multimodal strategy has become a prevailing method in addressing postoperative pain, owing to the absence of a single medicine that effectively suppresses nociception without

concomitant adverse reactions. [6] Ongoing research endeavors persist in the exploration of several methodologies and pharmacological agents aimed at extending the duration of regional anaesthesia and providing enhanced postoperative pain management. The notion of preemptive analgesia was initially proposed by Woolf [7], who conducted empirical investigations to illustrate that the development of enhanced pain sensitivity following an injury is mediated by central mechanisms. Pre-emptive analgesia refers to an anti-nociceptive intervention aimed at preventing the development of aberrant central processing of sensory information resulting from injuries.The preemptive studies have examined several therapeutic interventions, such as NSAIDS, intravenous opioids, intravenous ketamine, peripheral local anaesthetic, caudal and epidural analgesia, dextromethorphan, and gabapentin. [8] Magnesium sulphate has been employed in the medical treatment of obstetric and cardiac patients. Magnesium (Mg++) is a prevalent cation in the human body and plays a significant role in several metabolic events. Several researches have indicated that magnesium has the potential to be utilized as a preemptive analgesic agent. [9,10]
This study only focused on pregnant female patients, ensuring comparability across all three groups in terms of age, weight, and sex distribution.

The time of rescue analgesia, as measured by TRA-I, exhibited no significant differences across the three groups, with a p-value >0.05. Lidocaine has a relatively brief duration of action, often ranging from 60 to 90 minutes.[11]

Furthermore, the maximum action of magnesium sulphate (MgSO4) is achieved within a time frame of 60 minutes. Hence, at this particular stage (TRA I), the time for administering first rescue analgesia is comparable across all three groups because to the diminishing effects of lignocaine and the yet-to-be-attained peak impact of MgSo4. The comparability of these measures was also seen due to the administration of the research medication after duration of 60 minutes.

The intergroup comparison revealed a statistically significant prolongation in the overall duration of analgesia in group MS-50 compared to the other group ($p<0.01$). The results obtained were consistent with the findings of Elgebaly et al. [5], who conducted a study comparing the impact of intravenous magnesium sulphate administration (6gm i.v. as a loading dose over 20-30 mins, followed by a continuous infusion of magnesium sulphate at a rate of 2 gm per hour for 24 hours) to intrathecal fentanyl administration (25 mcg) in patients with severe pre-eclampsia undergoing caesarean section under spinal anaesthesia.

The researchers observed that the administration of magnesium sulphate resulted in a statistically significant increase in the duration of postoperative analgesia when compared to the use of intrathecal fentanyl (7.05 ± 1.95 hours and 6.85 ± 1.7 hours, respectively), ($p<0.01$). In a study conducted by Hwang et al [4], the efficacy of magnesium sulphate as a pain management intervention was investigated. The study focused on patients undergoing total hip arthroplasty under spinal anaesthesia. The experimental group received a dosage of 50 mg kg-1 of magnesium sulphate for 15 minutes, followed by a continuous infusion of 15 mg kg-1 h-1 until the conclusion of the surgery. The control group did not receive any magnesium sulphate. The results of the study indicated that the time to first experience of pain was 249 ± 41 minutes in the magnesium group, while it was 224 ± 38 minutes in the control group. Furthermore, the cumulative postoperative Visual Analogue Scale (VAS) score and patient-controlled analgesia (PCA) consumption were significantly lower in the magnesium sulphate group at 4, 24, and 48 hours after the surgery ($p<0.05$).

VAS scores at the beginning of pain and the need for rescue analgesia (TRA-I) exhibited similar and statistically insignificant results ($p>0.05$), throughout the three research groups. This lack of significance can be attributed to the fact that the impact of magnesium sulphate has not yet been realized at this particular stage. During the TRA-II stage, the MS-50 group had a higher level of analgesic efficacy, as evidenced by a lower Visual Analogue Scale (VAS) score of 7.16 ± 0.83. The observed differences between the treatment group and the MS-30 and NS groups were found to be statistically significant ($p<0.01$).

These findings are consistent with the research conducted by Hwang et al [4], Kiran et al [12], and Lee DH et al [13]. These studies investigated the effectiveness of a single dose of intravenous magnesium sulphate at a concentration of 50 mg kg-1 in 250 ml isotonic sodium chloride solution, administered intravenously along with an equal volume of normal saline over a period of 30 minutes prior to the induction of general anaesthesia. The researchers reached the conclusion that the preoperative administration of a magnesium sulphate infusion at a dosage of 50 mg kg-1 is associated with a reduction in postoperative pain and the need for further analgesic medication. Magnesium exerts its effects through the mechanism of NMDA receptor antagonism. The second idea posits that magnesium functions as a calcium channel antagonist. The potential analgesic impact of calcium channel antagonists may be attributed to an increase in the nociceptive threshold, which is likely due to the influx of calcium into the cell. The influx of calcium ions is

accountable for the liberation of neurotransmitters associated with nociception and the inflammatory response. [14]

An alternative method might potentially entail the inhibition of catecholamine release via sympathetic activation, wherein magnesium may contribute to the reduction of peripheral nociceptive sensitization or the surgical stress response. [14]

The MS-50 group had a higher level of sedative quality compared to the NS group ($p<0.01$). However, there was no statistically significant difference in sedation scores between the MS-30 and MS-50 groups ($p>0.05$).

These findings are consistent with the study conducted by Tramer et al. [16]. Kiran et al. [12] and Lee and Kwon [13] demonstrated improved sleep quality throughout the surgical phase with the perioperative use of magnesium sulphate, without any observed negative consequences. This phenomenon might be attributed to the fact that magnesium is commonly recognized as a depressant of the central nervous system (CNS).

The hemodynamic variables were similar and did not show any statistically significant differences. Tramer et al. [16], Hwang et al. [4], Koinig et al. [17], Telci et al. [15], Bilir et al. [6], Turan et al. [18], and Kogler J. [14] similarly observed that the magnesium and control groups exhibited comparable haemodynamic parameters ($p>0.05$). Furthermore, no instances of postoperative haemodynamic or respiratory instability were reported throughout the study periods. Significant complaints of discomfort at the infusion site were reported by all patients in both magnesium groups, in comparison to the NS group. Turan et al. [18] and Memis et al. [19] demonstrated the presence of mild to moderate discomfort upon injection of magnesium sulphate. The discomfort experienced upon injection of magnesium sulphate has been attributed to its mildly acidic pH range of 5.5 to 7.0.

Conclusion

The administration of intravenous magnesium sulphate at a dosage of 50 mg kg-1 demonstrated a statistically significant increase in the duration of analgesia, as well as a greater quality of analgesia, when compared to a dosage of 30 mg kg-1, specifically in the context of spinal anaesthesia. Additionally, the higher dosage of magnesium sulphate resulted in a considerable reduction in the consumption of postoperative analgesics. There were no notable occurrences of hemodynamic and respiratory instability, as well as any adverse effects or problems, following the administration of two doses of Magnesium sulphate.

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