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Intravenous Magnesium Sulfate for Acute Renal Colic Patients

Athar Fekry Lasheen

Ghada Adel Hegazy

ORIGINAL STUDY

Intravenous Magnesium Sulfate for Acute Renal Colic Patient

Athar F. Lasheen [a,*], Ghada A. Hegazy [b]

[a] Department of Emergency Medicine, Faculty of Medicine, Menoufia University, Menoufia, Egypt
[b] Department of Clinical Pharmacology, Faculty of Medicine, Menoufia University, Menoufia, Egypt

Abstract

Objectives: **To assess the role of magnesium sulfate in managing pain associated with renal colic in patients presenting at the emergency department (ED) of Menoufia University Hospital.**

Background: **Renal colic, typically caused by kidney stones, is characterized by intense pain due to ureteral smooth muscle spasms. Magnesium sulfate has shown promise in alleviating this pain by reducing these spasms.**

Patients and methods: **This randomized clinical trial included 51 ED patients with renal colic from October 2022 to March 2023. Patients were divided into two groups: group A received intravenous (i.v.) NSAIDs plus magnesium sulfate as an adjunct, while group B received i.v. magnesium sulfate alone. Patient demographics, medical history, and pain levels using the visual analog scale (VAS) were recorded at initial assessment, 20, 30, and 45 min posttreatment.**

Results: **The age range of patients was 18−60 years, with no significant differences between groups in age, sex distribution, underlying illnesses, or drug use ($P > 0.05$). Initial VAS scores and those at 20 min showed no significant difference between groups. However, by 30 min, both groups showed a significant decrease in VAS scores, with group A showing a highly significant reduction. Ten patients in group A and two in group B reported no pain at 45 min. Side effects did not significantly differ between groups.**

Conclusion: **Magnesium sulfate appears to be a safe adjunct therapy in the ED for managing renal colic pain effectively.**

Keywords: Emergency department, Magnesium sulfate, Pain management, Renal colic, Stones

1. Introduction

Pain is a significant factor driving patient visits to emergency departments (EDs) [1]. From 2006 to 2009, the incidence of renal colic in the United States rose from 289 to 306 cases per 100,000 individuals [2]. NSAIDs are the primary medication classes employed for the management of renal colic pain. However, several adverse events have been reported after NSAID administration [3].

Tocolytic agents, such as magnesium sulfate, have shown potential in reducing discomfort associated with ureteral stone movement by decreasing smooth muscle spasms in the ureter [4]. Magnesium sulfate acts by inhibiting the influx of calcium through the smooth muscle cell membrane, thereby reducing calcium levels necessary for muscle contraction [5,6]. Furthermore, it can attenuate muscle contractions by diminishing acetylcholine levels in neural terminals. Moreover, magnesium sulfate, in addition to its other actions, functions as an antagonist of the N-methyl-D-aspartate receptor. This has been utilized to decrease the requirement for analgesics, including opioids, by modulating the mechanism of central hypersensitivity [7].

Previous studies have investigated the potential use of magnesium sulfate as an adjunct for postoperative analgesia [8]. Furthermore, research has demonstrated successful management of cancer-related neuropathic pain with magnesium sulfate [9−11].

Ongoing studies are currently evaluating the efficacy and safety of magnesium sulfate in reducing patient pain, particularly in the context of ED. This

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* Corresponding author at: Babel, Tala City, Menoufia Governorate 32841, Egypt.
E-mail address: lasheen.asar@gmail.com (A.F. Lasheen).

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work aimed to evaluate the contribution of magnesium sulfate to the management of renal colic-related pain in the patients attending the ED at Menoufia University Hospital.

2. Patients and methods

This study was conducted at the Emergency Department of Menoufia University Hospital, Egypt, between January and June 2023. The Institutional Review Board at the Faculty of Medicine, Menoufia University, approved the study (12/2022PHAR10). Informed consent was obtained from patients after illustrating the study's aims and objectives.

Patients were separated into two groups [group A: patients getting intravenous (i.v.) NSAIDs medicines plus magnesium sulfate as an adjunct; group B: patients receiving i.v. magnesium sulfate as the first medication for pain relief].

Patients aged 18−60 years attending the ED with acute renal colic were investigated. Exclusion criteria were patients who had a known arrhythmia or heart block, cardiac failure, myocardial injury, underlying bradycardia (heart rate <60 beat/min), renal failure, hepatitis, alcoholics, patients who are prescribed to take narcotics, barbiturates, antidepressants, antipsychotics, sleeping aids, calcium channel blockers, people with myasthenia gravis and other neuromuscular illnesses, and pregnant women were excluded from the study. Additionally, individuals who had taken any type of painkillers or sedatives during the previous 6 h of admission to the ED were also excluded.

Following taking a thorough medical history and a clinical examination (heart rate, systolic blood pressure, respiratory rate, random blood sugar, and temperature were assessed in all studied patients), the patient's pain level was assessed using a visual analog scale (VAS) on which 0 represents no pain, and 10 represents the most agonizing pain imaginable. NSAIDs [ketorolac 10 mg intramuscular injection for group A patients and i.v. magnesium sulfate (2 ml of 50 % solution mixed with normal saline solution to attain 100 ml infused over 15 min)] were given to the patients. The senior emergency medicine resident and assistant nurse oversaw the whole procedure, which was carried out while being continuously monitored for cardiac, respiratory, blood pressure, and pulse oximetry.

After the medicine had been administered, the patient's pain levels were again assessed and recorded at 20, 30, and 45 min. All patients in both groups received an additional i.v. NSAIDs if the pain persisted. Follow up on the appearance of any side effects of the drugs, such as dizziness, gastric pain, hypotension, nausea, and vomiting.

The VAS is a commonly utilized method for assessing pain severity and evaluating the effectiveness of pain relief in the emergency room. During the process, healthcare providers prompt patients to indicate their perceived pain intensity by marking a point on a line that spans between two endpoints. The VAS consists of a continuous scale, typically measuring 100 mm in length, portrayed either horizontally VAS or vertically VAS. These endpoints are anchored by verbal descriptors representing “no pain” and “worst imaginable pain.”

SPSS (Statistical Program for the Social Sciences; SPSS Inc., Chicago, Illinois, USA), version 23 for Microsoft Windows was used to analyze the data. Descriptive statistics are presented as frequencies and percentages for categorical variables and as mean and SD for numerical variables. The χ^2 test was used to assess the association between qualitative variables. A cut-off point P value of 0.05 is considered significant.

3. Results

A total of 51 patients were included in our study. The mean age of patients was 38.68 ± 12.21 and 41.73 ± 11.68 years for group A and group B, respectively. Males were more than females in both groups; however, no significant difference between the two groups regarding the sex. Only six (24 %) and eight (30.77 %) patients suffered chronic illness in group A and group B, respectively. Furthermore, drug abuse was not frequently reported in our cohort (16 vs. 7.69 %, respectively). All baseline characteristics were comparable and did not show any significant difference between the two groups (Table 1).

Regarding the vital signs, all patients were relatively conscious and stable to be managed within the emergency room. A slight increase in the mean

Table 1. Baseline characteristics for the patients.

Characteristics	Group A ($N = 25$)	Group B ($N = 26$)	P value
Age (years)	38.68 ± 12.21	41.73 ± 11.68	0.37
Sex			
Male	22 (88)	20 (76.92)	0.3
Female	3 (12)	6 (23.08)	
Chronic illness			
Yes	6 (24)	8 (30.77)	0.59
No	19 (76)	18 (69.23)	
Drug abuse			
Yes	4 (16)	2 (7.69)	0.36
No	21 (84)	24 (92.31)	

Data are represented as mean ± SD or frequency and percentage.

Table 2. Clinical data and vital signs of included patients in both groups.

Vital sign	Group A ($N = 25$)	Group B ($N = 26$)	P value
Respiratory rate (breath/min)	21.76 ± 4.15	22.77 ± 3.52	0.35
Systolic blood pressure (mmHg)	128.6 ± 24.13	123.65 ± 22.43	0.45
Heart rate (beat/min)	85.6 ± 19	92.54 ± 20.82	0.22
Random blood sugar (mg/dl)	169.2 ± 70.07	160.38 ± 73.52	0.66
Temperature (°C)	37.52 ± 0.72	37.51 ± 0.8	0.97

Data are presented as mean ± SD.

random blood sugar was noticed in both groups; however, it is clinically irrelevant. Patients in both groups were comparable in their respiratory rates, systolic blood pressure, heart rate, random blood sugar, and temperature (Table 2).

At the first pain evaluation, patients in both groups experienced quite identical VAS without a significant difference. Similarly, after 20 min, there was a minimum decline by nearly one point in VAS in both groups, yet with no statistically significant difference between the two groups. Interestingly, both groups had a substantial decrease in VAS after 30 min (group A: 2.56 ± 1.33 vs. group B: 4.92 ± 1.13, $P < 0.0001$). Group A experienced a greater decline by achieving a success rate in lowering pain by about four points than the baseline on VAS. Moreover, after 45 min, it was found that around (10; 40 % vs. 2; 7.69 %, $P < 0.0001$), in group A and group B, respectively, did not report any discomfort. Detailed data of VAS at the start, 20, 30, and 45 min are represented at Table 3.

On the other hand, when comparing the VAS at the baseline and after 30 min by group, both therapeutics managed to significantly decline the VAS. Group A experienced a decline in the VAS from 6.84 ± 1.89 at the baseline to 2.56 ± 1.33 after 30 min ($P < 0.0001$), and group B experienced a decline in the VAS from 7.12 ± 1.48 at the baseline to 4.92 ± 1.13 ($P < 0.0001$). Detailed data of VAS at the start, 20, and 30 min, classified by group, are represented in Table 4.

Table 3. Visual analog scale through time to the included patients in both groups.

VAS through time	Group A ($N = 25$)	Group B ($N = 26$)	P value
VAS initial assessment	6.84 ± 1.89	7.12 ± 1.48	0.5635
VAS after 20 min	6.04 ± 1.67	6.42 ± 1.27	0.35994
VAS after 30 min	2.56 ± 1.33	4.92 ± 1.13	<0.0001[a]
Pain-free after 45 min	10 (40.0)	2 (7.69)	<0.0001[a]

Data are represented as mean ± SD or frequency and percentage.
VAS, visual analog scale.
[a] Significant difference.

Table 5. Side effects developed in studied groups.

	Group A ($N = 25$)	Group B ($N = 26$)	P value
Dizziness	1 (4)	2 (7.69)	0.5753
Gastric pain	1 (4)	0	0.4902
Hypotension	0	4 (15.38)	0.1104
Nausea	4 (16)	1 (3.85)	0.14453
Vomiting	2 (8)	1 (3.85)	0.5285

Data are represented as frequency and percentage.

Nausea was the most common side effect reported by patients in group A, four (16 %), while hypotension was the most common side effect noticed among patients in group B, four (15.38 %). In general, side effects were rare events in both groups and comparable with no significant differences. Table 5 summarizes the side effects among patients in the two groups.

4. Discussion

This study aimed to evaluate the effectiveness of i.v. magnesium sulfate as an adjunct for the treatment of acute renal colic in patients who visited the emergency room at Menoufia University hospitals. Renal colic stands as one of the most severe forms of human discomfort, affecting ~1.2 million individuals annually and accounting for 1 % of all hospital admissions. The incidence of renal colic is twice in the presence of the family history of stone formation [12]. Immediate intervention is crucial in managing

Table 4. Visual analog scale compared by a group of included patients.

	Group A ($N = 25$)		Group B ($N = 26$)	
VAS initial assessment	6.84 ± 1.89	0.39	7.12 ± 1.48	0.07
VAS after 20 min	6.04 ± 1.67		6.42 ± 1.27	
VAS initial assessment	6.84 ± 1.89	<0.0001[a]	7.12 ± 1.48	<0.0001[a]
VAS after 30 min	2.56 ± 1.33		4.92 ± 1.13	

Data are represented as mean ± SD.
VAS, visual analog scale.
[a] Significant difference.

the pain associated with renal colic, as it commonly presents in episodic waves lasting between 20 and 60 min. In accordance with the recommendations set forth by the European Association of Urology, NSAIDs are advocated as the primary therapeutic approach for renal colic, with opioids serving as a secondary option [13].

Optimal pain relief for renal colic necessitates a pain reliever with a high safety profile and minimal potential for significant interactions with other pharmacological agents. The incorporation of magnesium sulfate as an adjunct therapy to the established renal colic management protocol appears promising, as it has the potential to alleviate patient pain and decrease the requirement for additional morphine doses while maintaining stable hemodynamic measurements [14].

Males outnumbered females in the current study, with the mean ages of the patients in the analyzed groups being 38.68 ± 12.21 and 41.73 ± 11.68, respectively. 30.77 and 24 %, respectively, of the patients in group B had a history of comorbidities. According to El Sayed *et al.* [12], the two groups were in comparable conditions in terms of mean age ($P = 0.366$), sex distribution ($P > 0.05$), underlying illness ($P = 0.588$), and drug misuse ($P = 0.357$).

Prior to the administration of the drugs, it was noted that there was no statistically significant difference between the two groups' vital signs, including systolic blood pressure, pulse, respiratory rate, and temperature. This finding is in agreement with Wahba *et al.*'s [15] study from 2013, which found no statistically significant difference between the two groups' vital signs when magnesium sulfate was administered for postoperative pain in major nonlaparoscopy surgeries.

In the present study, the severity of pain was evaluated using the VAS. The results indicated that there was no significant difference between the pain scores of the two groups during the initial assessment and 20 min after the administration of the drugs. Additionally, both groups demonstrated an equal success rate in reducing pain by at least one point on the VAS. However, after 30 min, both groups experienced a substantial decrease in VAS scores, with group A showing the greatest decline. Interestingly, a previous study conducted by Majidi and Derakhshani [16] reported that both groups achieved a success rate of 91.1 % in reducing pain by at least three points on the VAS after 20 min. Based on the findings of the present study, magnesium sulfate demonstrated a comparable effect and an equal success rate in treating patients suffering pain due to acute renal colic when compared to NSAIDs. However, it appears that the group receiving magnesium sulfate took slightly longer to achieve a pain-free state. This observation also aligns with the outcomes reported by Majidi and Derakhshani [16].

In the present trial, it was observed that individuals with acute renal colic who received magnesium sulfate along with standard care experienced a reduction in pain intensity and required fewer additional NSAIDs. The research conducted by Jokar *et al.* [17] further emphasized the significance of magnesium sulfate as an adjunct treatment for renal colic, highlighting its potential to reduce the need for opioid analgesics. However, Chen *et al.* [18] discovered that the administration of additional magnesium sulfate may not provide benefits for individuals who had already received NSAIDs or morphine for renal colic.

After a 45-min interval, it was observed that ~10 (40 %) patients in group A reported no discomfort, whereas only two patients in group B had a similar outcome. This finding aligns with the research conducted by Kocman *et al.* [19], which indicated that patients who underwent laparoscopic cholecystectomy experienced reduced postoperative discomfort when they received a modest dose of magnesium sulfate via injection. Additionally, the study conducted by Delavar *et al.* [20], comparing the effects of magnesium sulfate and ketorolac in the treatment of migraines, suggested that both medications had a similar impact during the acute phase, but magnesium sulfate exhibited better performance 1 and 2 h after drug administration.

Regarding adverse medication reactions, there was no statistically significant difference between the two groups, and only four (15.38 %) of the patients in group B experienced mild hypotension. These findings were corroborated by Chen *et al.* [18], who noted that magnesium sulfate usage for a brief period did not affect the hemodynamic or respiratory state.

The study has several limitations that should be taken into consideration. First, the study was conducted at a single center, which may limit the generalizability of the findings to other healthcare settings or populations. The results may not be representative of the wider patient population or reflect variations in clinical practices across different centers. Second, the sample size of the study was relatively small which may have limited the ability to detect small but meaningful differences between groups or treatments. Furthermore, the study had a higher proportion of male participants, which may introduce sex bias and limit the generalizability of the findings to female patients with acute renal colic. Additional limitations may include potential confounding factors that were not accounted for and

the possibility of measurement bias or subjective interpretation of pain scores using the VAS. These limitations should be considered when interpreting the study's results and applying them to clinical practice. Future research is still needed to assess the effectiveness of magnesium sulfate as an adjunct pain relief to patients with acute renal colic in the emergency room.

4.1. Conclusion

Magnesium sulfate can be used as an adjunct treatment for patients with acute renal colic in EDs to lessen patients' pain intensity. This is because the drug has minimal side effects and is simple to administer, and on the other hand, opioid prescriptions cause problems.

Ethical considerations

The Institutional Review Board at the Faculty of Medicine, Menoufia University, approved the study (12/2022PHAR10). Informed consent was obtained from patients after illustrating the study aims and objectives.

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Conflicts of interest

There are no conflicts of interest.

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