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Comparative Study of Influence of General Anaesthesia Alone versus General Anaesthesia with Magnesium Sulfate on Post-Operative Inflammatory Biomarkers after Elective Abdominal Hysterectomy

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Abstract

Background: As the second most common intracellular cation, behind potassium, enzyme activities in humans depend on magnesium. This study examined the effects of three blood inflammatory biomarkers—C-reactive protein, interleukin 6, and procalcitonin—after an elective abdominal hysterectomy between a general anesthetic alone and a general anesthesia supplemented with magnesium sulphate. Methods: This randomized controlled study included forty patients who chose to have a general anesthesia for their abdominal hysterectomy. Group 1 patients were all given general anesthesia. Under the influence of general anesthesia, patients in Group 2 received magnesium sulfate. There was a significant difference in IL6 levels between the groups given general anesthesia and those given MgSO4 at 1 and 4 hours postoperatively (P value < 0.001). On the first and fourth hours after surgery, the procalcitonin levels of the MgSO4 group were noticeably lower than those of the general anesthetic group (p < 0.001, respectively). Furthermore, the MgSO4 group showed a significantly reduced CRP level four hours after the procedure, in contrast to the group that had general anesthesia (P value < 0.001). In all groups, there was a link between the level of interleukin-6 at 4 hours and the duration of the surgical procedure (p value 0.001 and <0.001 in group I and group II respectively), indicating that the surgery may have been more complex. End result: When magnesium sulphate was administered in addition to general anesthesia after an elective abdominal hysterectomy, the levels of inflammatory biomarkers such C-reactive protein, interleukin 6, and procalcitonin were much lower than when general anesthetic was administered alone. There was a decrease in discomfort, cumulative intraoperative fentanyl dosage, and morphine dose when magnesium sulphate was used.

Keywords: General anesthesia, magnesium sulfate, and inflammatory biomarkers are all things that are linked to elective hysterectomy.

1.Introduction

As the second most prevalent cation inside cells, second only to potassium, magnesium is involved in almost all enzymatic activities in the body. Among the almost 600 enzymatic processes in which it is involved, two are protein synthesis and energy metabolism [1].

Mg2+ functions as an extra signaling messenger during T cell activation. Therefore, a magnesium shortage may lead to immunodeficiency, an increased acute inflammatory response, a decreased antioxidant response, and oxidative stress. Supplementing with magnesium causes a reduction in NF-κB, IL6, and tumor necrosis factor alpha, which in turn triggers an anti-inflammatory response. Further, boosting glutathione [GSH] content and improving mitochondrial function are two additional benefits of magnesium supplementation that reduce oxidative stress [2].

In addition, magnesium inhibits calcium entry into cells via noncompetitively blocking the N-Methyl-D-aspartic acid [NMDA] receptor. A combination of magnesium and the NMDA receptor mediates pain modulation. It is possible that magnesium and other physiological calcium antagonists at voltage-gated channels contribute to anti-nociception mechanisms [3].

Magnesium deficiency promotes inflammation by priming phagocytes, enhancing oxidative burst, activating endothelial cells, and increasing cytokines [4].

As shown by a decrease in interleukin-6 and TNF-α levels in the blood after elective CABG with CBP, MgSO4 infusion may alleviate the inflammatory response [5].

There is no doubt that procalcitonin outperforms other recognized biochemical indicators for inflammatory abdominal disorders when used in tandem with comprehensive patient clinical examinations for the purposes of differential diagnosis, treatment monitoring, response assessment, and outcome prediction [6].

Perioperative cytokine expression is modulated by a wide range of surgical trauma intensities, anesthetic types, and drugs. Inflammatory cytokines contribute to organ dysfunction after surgery, which may affect the central nervous system, heart, lungs, liver, and kidneys. Inhibitors and antagonists of cytokines may reduce tissue and organ dysfunction during surgery by protecting tissues and organs from traumatic injury [7].

Even in the absence of a sepsis or infection diagnosis, individuals undergoing elective surgery in the early or post-traumatic period may exhibit an increase in inflammatory biomolecules such as procalcitonin and C-reactive protein [8].

After an elective abdominal hysterectomy, three inflammatory biomarkers—C-reactive protein, interleukin 6, and procalcitonin—are measured in the blood. This study intended to compare the effects of general anesthesia alone with those of general anesthesia with magnesium sulphate.

2.Patients and methods

This randomized controlled study included forty individuals who willingly had an abdominal hysterectomy under general anesthesia. Every single case included an open laparotomy, specifically a Pfannenstiel incision. From January 2023 through December 2023, the study was carried out at the main operating theatre of Benha University Hospital.

Benha University Hospital's Local Ethical Committee provided its approval, therefore the study could go forward. Prior to their inclusion in the experiment, all patients were requested to provide their informed consent.

To be eligible, participants needed to be 40–60 years old, have an ASA level of I or II, and be undergoing a general anesthesia for an elective abdominal hysterectomy.

Conditions such as a body mass index (BMI) of 30 kg/m2 or higher, diabetes, septicemia, untreated arrhythmia, neuromuscular disorders, organ dysfunctions (cardiac, respiratory, neurologic, renal, or liver disorders), hypersensitivity to magnesium sulfate, patient refusal, or other medical issues would disqualify a patient from participating.

Classification: The patients were divided into two equal groups and allocated at random: Group 1 patients were all given general anesthesia. General anesthesia and magnesium sulfate were also administered to patients in Group 2.

Each of the cases studied underwent the following: Questions regarding the patient's age, residence, occupation, habits, and pertinent comorbidities like hypertension, diabetes, heart disease, kidney disease, chronic obstructive pulmonary disease, and special dietary needs are all part of the process of collecting demographic information and medical history. Thorough medical assessment: Among the many components of a thorough physical examination are the following vital signs: pulse rate, temperature, blood pressure, and respiratory rate. Full blood count, random blood sugar, liver function, and kidney function tests are all part of the comprehensive exam.

It was strongly advised that patients continue fasting in accordance with the preoperative guidelines. Two G 18 wide pore cannulas were used to keep an intravenous [IV] access open. The second group, which consisted of magnesium, had 75 mg/kg of magnesium sulphate in 100 mL of a 0.9% sodium chloride solution about 30 minutes before balanced general anesthesia was administered. While the patient was receiving the infusion, their vitals were tracked every 5 minutes: patellar reflex, blood pressure, heart rate, and breathing rate. In case overdose symptoms were observed—which include changes in electrocardiogram (ECG) patterns like a prolonged PR interval and broad QRS, a diminished or nonexistent deep tendon response, and a lowered respiratory rate—the magnesium sulphate was stopped and 1 g of calcium gluconate was slowly administered intravenously as an antidote.

Electrocardiogram, pulse oximetry, non-invasive blood pressure, urine output, and neuromuscular block were among the vital signs that were closely monitored during the surgery.

All patients were given a balanced general anesthesia without any premedication required. To achieve balanced general anesthesia, 1 μg/kg of fentanyl, 2 mg/kg of propofol, and 0.5 mg/kg of atracurium were given intravenously. To keep the patient anesthetized following intubation, a mixture of balanced air and oxygen, 1.2% isoflurane, and atracurium 0.1 mg/kg every 20 minutes was administered. To address any signs of sympathetic activation, such as sweating, bleeding, or an increase in heart rate or blood pressure, fentanyl was administered in lower doses at a rate of 0.5 μg/kg and given again depending on the response. Both groups had their complete dose recorded after the procedure was over. After the procedure, patients were given neostigmine (0.05 mg/kg) and atropine (0.02 mg/kg) to prevent neuromuscular inhibition.

afterwards surgical

Patients were sent to the post-anesthesia care unit to have their blood pressure, heart rate, breathing rate, level of awareness, and patellar reflex (deep tendon reflex) checked until they were ready to be released.

At the end of the procedure, the plan for pain management is to inject 5 milliliters of isobaric Marcaine (0.5 milliliters) and 10 milliliters of 2% lidocaine (0.5 milliliters) into the incision site.

A visual analogue scale was used to quantify the pain levels of each and every patient. An easy way to measure pain is using the Visual Analogue Pain Scale, which employs a 10-centimeter line where 0 is the least painful and 10 is the most painful a person has ever felt. There is no discomfort. I would appreciate it if you could rank the level of pain from 1 to 9, with 9 being the most severe. Intensity of pain: ten.

If the pain is not too severe, acetaminophen (10 mg/kg) is given intravenously. Patients undergoing post-anesthesia treatment who report moderate to severe pain are given intravenous morphine in 1 mg increments as needed throughout the monitoring period. The total dose of morphine is documented for the duration of the observational period.

Data analysis using statistics

The statistical package SPSS v27, created by IBM (Chicago, IL, USA), was used for data analysis. For this comparison, we used an unpaired Student's t-test and an analysis of variance (ANOVA) [F] test. The quantitative data was presented as means and standard deviations [SD]. Qualitative variables were shown using percentages and frequencies, and where relevant, the Chi-square test or Fisher's exact test were used for analysis. To see if there was any relationship between the variables, we used Pearson's correlation. A two-tailed P value below 0.05 was used to assess statistical significance.

3.Results

When comparing the two groups according to age, weight, BMI, ASA, or duration of operation, there was no statistically significant difference. Table 1 displays the results of the pre-operative clinical and laboratory tests, which did not reveal a statistically significant difference between the two groups. The cumulative dose of fentanyl used throughout the intraoperative period differed significantly between the two groups (Table 1, p = 0.02). During the perioperative time, the magnesium group required less fentanyl than the other group. Table 2 demonstrates that IL6 levels were considerably lower in the MgSO4 group one hour after surgery when contrasted with the general anesthesia group (P value < 0.001). Moreover, the procalcitonin level was significantly lower in the MgSO4 group compared to the general anesthesia group one hour after surgery (P value = 0.045). One hour post-operatively, the magnesium group had a lower C-reactive protein level than the general anesthetic group, but there was no statistically significant difference between the two groups (P value 0.94). Four hours following surgery, the MgSO4 group showed a considerably lower IL6 level (P value < 0.001) in comparison to the general anesthesia group. In addition, the procalcitonin level was considerably lower in the MgSO4 group compared to the general anesthetic group after 4 hours postoperatively (P value < 0.001). Furthermore, four hours after surgery, the MgSO4 group had a significantly reduced CRP level (P value < 0.001) in contrast to the group administered general anesthetic. There was a statistically significant correlation between the duration of the operation and the levels of interleukin-6 and procalcitonin at 4 hours after the procedure (Table 3). Group I had a p value of 0.001 and group II had a p value of less than 0.001, indicating a clear association between the level of interleukin-6 at 4 hours and the duration of the operation, demonstrating the complexity of the process. The total length of time that each group went under the knife was also shown to be strongly related to procalcitonin at 4 hours (p = 0.013 for group I and 0.039 for group II, respectively). Still, neither group's CRP nor the duration of operation were significantly related (p values of 0.207 and 0.281, respectively). Chapter 4

In comparison to the other groups, the magnesium group consistently had lower VAS scores across all time periods (p<0.001). Throughout the duration of the study, the magnesium group consumed a much lower total dose of morphine than the control group (p < 0.001). Section 5

The main characteristics and total surgery time for the study groups are shown in Table 1.

	Group I N=20 [group]	Group II N=20 [Magnesium group]	P value
Age\ years	49.2 ± 4.2	50.6 ± 5.34	0.474
Weight	76.05 ± 6.94	76.2 ± 4.84	0.937
BMI	28.04 ± 1.19	28.61 ± 1.19	0.138
ASA			
I	9	8	0.752
II	11	12	
Surgical duration [minutes]	99.85 ± 11.68	100.7 ± 9.17	0.799

Table (2) Pre-operative statistics evaluated for both groups and total fentanyl dosage taken during surgery:

	Group I N=20 [group]	Group II N=20 [Magnesium group]	P value
MAP	90.9 ± 5.01	92.55 ± 6.12	0.357
Hb	11.92 ± 0.80	12.14 ± 0.85	0.394
Serum creatinine	0.91 ± 0.18	0.94 ± 0.19	0.587
SGOT	32.25 ± 5.86	31.45 ± 6.13	0.676
SGPT	32.2 ± 5.5	31.4 ± 6.46	0.676
Total fentanyl dose [micrograms]	130 ± 44.13	105 ± 15.39	0.02*

***: statistically as P value <0.05**

Inflammatory biomarkers measured one hour and four hours after surgery in the two groups (Table 3):

	Group I N=20 [group]	Group II N=20 [Magnesium group]	P value
1-hours post-operatively			
CRP [mg/L]	17.45± 14.07	10.84± 10.97	0.94
IL-6 [pg/ml]	49.81± 11.84	18.17± 6.42	<0.001*
PCT [ng/ml]	0.144± 0.225	0.036± 0.02	0.045*
4-hours post-operatively			
CRP [mg/L]	40.95± 13.77	26.05± 9.67	<0.001*
IL-6 [pg/ml]	94.36± 23.05	32.25± 11.14	<0.001*
PCT [ng/ml]	0.39± 0.25	0.16± 0.06	<0.001*

*: statistically as P value <0.05

Table (4) Time to inflammatory marker level correlation with surgical length at 4 hours postoperatively:

		Surgical duration	
		Pearson correlation coefficient	**P value**
IL6 level at 4 hours	**Group I [group]**	0.685	0.001*
	Group II [Magnesium group]	0.713	<0.001*
Procalcitonin at 4 hours	**Group I [group]**	0.543	0.013*
	Group II [Magnesium group]	0.464	0.039*
CRP at 4 hours	**Group I [group]**	0.207	0.382
	Group II [Magnesium group]	0.281	0.230

***: statistically as P value <0.05**

Table (5) VAS score after surgery at various time periods and total morphine dosage after surgery for the two groups:

Post-operative VAS	Group I N=20 [group]	Group II N=20 [Magnesium group]	P value
At first hour	9.05 ± 0.69	8.0 ± 0.795	<0.001*
At second hour	7.40 ± 0.82	6.05 ± 1.1	<0.001*
After 6 hours	4.60 ± 0.50	3.25 ± 0.85	<0.001*
Total morphine dose [milligrams]	7.05 ± 0.69	6.05 ± 0.83	< 0.001*

*: statistically as P value <0.05

4.Discussion

There was no statistically significant difference between the two groups with respect to age, weight, BMI, and ASA. Additionally, the clinical and laboratory data collected before to surgery did not vary significantly between the two groups. The amount of time spent in surgery was also not significantly different between the two groups.

The current study documented the total amount of fentanyl given throughout the operation. Magnesium patients required significantly less fentanyl during surgery on average (p = 0.02) than those in the control group.

The findings are consistent with those of a randomized trial with 122 hysteroscopy patients. The intraoperative fentanyl need was significantly lower in the magnesium group as compared to the control group [9].

It is worth mentioning that the pain level was assessed using a VAS score at 1, 2, and 6 hours after the operations. The VAS ratings of the groups were consistently higher than those of the MgSO4 group at all time points (p<0.001).

This is in agreement with the findings of an observational study that aimed to evaluate the analgesic effects of magnesium sulfate and intravenous diclofenac in patients undergoing a total abdominal hysterectomy. Group A, which received magnesium sulphate postoperatively, used less opioids, particularly pethidine, on the first postoperative day after abdominal hysterectomy than group B, which received diclofenac sodium. A p-value<0.001 was found between the mean pethidine consumption of 2.07±0.52 milligrams/kg ±SD in Group A and 2.60±0.62 in Group B. These two groups are statistically distinct from one another. The results showed a statistically significant decrease in the average pain score in the research group, indicating that magnesium sulfate was effective as an analgesic after surgery [10].

Furthermore, the current study documented the total amount of morphine given after surgery. The mean cumulative morphine dose differed significantly (p<0.001) between the magnesium group and the other group.

Results from a randomized, double-blind prospective study of sixty women who met the criteria for a hysterectomy were comparable. After receiving 50 mg/kg of magnesium sulphate before surgery and 15 mg/kg of maintenance infusion during the operation, the magnesium group showed a significant decrease in pain levels and total morphine consumption rates when compared to the placebo group [11].

A randomized, double-blind, placebo-controlled trial was also planned to assess the efficacy of a single modest intravenous dose of magnesium sulfate in reducing post-TAH pain under balanced general anesthesia.Pain was evaluated at 0, 6, 12, and 24 hours after the operations using the Numeric Rating Scale [NRS]. Completed item. At 6, 12, and 24 hours after the procedure, the pain ratings of the magnesium group were significantly lower (P < 0.05) [12].

Despite a decrease in heart rate, our experiment found no statistically significant changes in heart rate measures during magnesium infusion (p= 0.705).

Although the average arterial blood pressure of patients decreased after magnesium infusion, there was a significant difference in their average arterial blood pressure throughout the infusion (p <0.001).

After one hour after surgery, our study revealed that two inflammatory markers were significantly reduced in the magnesium group (Group II) compared to the control group (Group I). In Group II, the mean IL-6 level was 18.17 ± 6.4 pg/ml, which was significantly lower than Group I's mean of 49.81± 11.84 pg/ml [$p < 0.001$]. In the same way, Group II's mean PCT level was significantly lower (0.036±0.02 ng/ml) than Group I's (0.144±0.225 ng/ml) (p 0.045). A difference ($p = 0.09$) was shown by the fact that the mean CRP level in Group II was 10.6 ± 10.97 mg/L, whereas in Group I it was 17.45 ± 14.07 mg/L. The much lower levels of IL-6 and PCT in Group II suggest that their inflammatory response was less severe compared to Group I.

Also, four hours post-op, the mean of all inflammatory indicators was significantly lower in Group II compared to Group I. The mean IL-6 level in Group II was 32.25±11.14 pg/ml, which was significantly lower than the mean in Group I (94.36±23.05 pg/ml) [$p < 0.001$]. In Group I, the average level of PCT was 0.39 ± 0.25 ng/ml ($p < 0.001$), but in Group II, it was much lower at 0.16 ± 0.06 ng/ml. A CRP level of 40.95 ± 13.77 mg/L was recorded in Group II, whereas a level of 26.05 ± 9.67 mg/L was recorded in Group I ($p < 0.001$). Their IL-6, PCT, and CRP levels were much lower than Group I's, suggesting that Group II may have had a less severe inflammatory reaction.

The levels of procalcitonin and interleukin-6, measured four hours after surgery, were shown to be strongly linked with the overall amount of time under anesthesia. Group I and group II showed a clear link between the amount of interleukin-6 at 4 hours and the duration of the operation ($p = 0.001$ and <0.001, respectively), suggesting that the procedure was tough. Total time spent under the knife was also shown to be strongly related to procalcitonin at 4 hours ($p = 0.013$ for group I and 0.039 for group II), suggesting that these two groups had similar procedures. There was no statistically significant relationship between CRP and operation duration when comparing the two groups ($p = 0.207$ for group I and 0.281 for group II, respectively).

Nevertheless, the purpose of a prospective, double-blind, randomized controlled experiment was to find out if adding magnesium sulphate to the periarticular infiltration analgesia [PIA] cocktail helped patients undergoing total knee arthroplasty [TKA] with pain management and functional outcomes. The scientists discovered that the magnesium sulfate group had much lower levels of IL-6 and CRP on days 1, 2, and 3 after surgery compared to the control group. Incorporating magnesium sulfate into the cocktail may have contributed to its anti-inflammatory effects [13].

5.Conclusion

Magnesium sulphate added to general anesthesia significantly reduced levels of inflammatory biomarkers such as C-reactive protein, interleukin 6, and procalcitonin after elective abdominal hysterectomy compared to general anesthetic alone. Additionally, it was seen that the addition of magnesium sulfate reduced discomfort and lowered the total intraoperative morphine and fentanyl dosages. The time it took to perform surgery and, maybe, the difficulty of the procedure were both positively correlated with inflammatory biomarkers, especially IL6 and procalcitonin.

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Authorial contribution

The authoring of the study was done by each author in equal measure.

Possible prejudices

Prejudices of any kind do not exist.

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