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ORIGINAL ARTICLE

Comparison of the efficacy of morphine and magnesium sulphate versus morphine alone to manage pain after coronary artery bypass grafting.

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ABSTRACT… Objective: To compare the efficacy of morphine and magnesium sulphate versus morphine alone to manage pain after coronary artery bypass grafting. **Study Design:** Prospective Cohort Study. **Setting:** Department of Anesthesiology, CPEIC Multan. **Period:** June 2025 to December 2025. **Methods:** Department of Anesthesiology, CPEIC Multan. **Methods:** Sample size was calculated through OpenEpi online software using formula for cohort study. Where, Efficacy in magnesium sulphate group = 68%, Power of the study = 80%, Efficacy in morphine only group = 17%, Confidence level = 95%, Sample size =60 (30 in each group). Sampling technique was Non-probability consecutive sampling. Inclusion Criteria, Age 35-65 years, either male or female gender, planned to undergo coronary artery bypass grafting. The data was analysed through SPSS version 23. Efficacy between the two groups was compared using chi-square test and p-value ≤ 0.05 was taken as significant. Post stratification chi-square test was applied and p-value ≤ 0.05 was taken as significant. **Results:** A total of 60 patients were enrolled into the study in equal proportions. Morphine plus Magnesium Sulphate (MM) group had significantly lower mean Visual Analogue Scale (VAS) pain scores at 6, 12 and 24 hours than the Morphine alone (M) group (p <.05). The MM group had a much lower requirement to rescue analgesia, and the efficacy was found to be 68% as compared to 17% in the M group (p=0.001). More so, the ICU stay and intubation time were much shorter in the MM. **Conclusion:** Morphine in combination with magnesium sulphate is more effective than morphine in treatment of postoperative pain following coronary artery bypass grafting. Magnesium sulphate is a safe and cost-effective adjunct to cardiac anesthesia, it substantially decreases opioid use, decreases pain scores, and length of stay in the ICU, indicating magnesium sulphate as a useful option.

Key words: Coronary Artery Bypass Grafting, Efficacy, Morphine, Magnesium Sulphate, Morphine Alone, Manage Pain.

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INTRODUCTION

Unusual emotional and sensory sensations brought on by tissue injury are referred to as pain.[1] Among the various forms of pain, post-operative discomfort is a significant stressful event for patients, potentially impeding deep inhalation, efficient coughing, and early mobilisation.[2] Therefore, a key component of postoperative therapy is pain management. The sternum opening and internal mammary artery (IMA) graft preparation during coronary artery bypass grafting (CABG) surgery can be quite painful.[3] A variety of drug delivery methods are employed, such as rectal, intramuscular, intravenous, or oral injections, as well as patient control analgesia (PCA).[4]

Typically, opioids are given both during and right after the procedure. Despite their relative effectiveness, excessive dosages of opioids can have a number of negative side effects, including constipation, drowsiness, nausea, vomiting, itching, and respiratory depression.[5] A common medication in the fields of pain management, critical care, and anesthesiology is magnesium sulphate.[6] As a supplement, it is also used to treat eclampsia, premature labour, asthma attacks, myocardial protection following ischemia, postoperative pain management, and haemodynamic stability during intubation.[7] Magnesium's function in the N Methyl D Aspartate (NMDA) portion of Gamma Amino Butyric Acid (CABG) receptors is its most significant mechanism of action. These receptors, which are present in nerve endings, have the ability to control inflammation and pain.[8]

Ahmad RA et al enrolled a total number of 150

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patients of both genders undergoing CABG. It was observed that, in morphine group (M), the mean VAS score after 4, 12 and 24 hours of operation was 5.24±1.61, 5.8±2.27 and 5.44±2.27 respectively while it was better in morphine plus magnesium group (MM), 4.36±2.58, 3.48±2.10 and 4.12±1.05 respectively.[9] Alavi SM et al recruited 185 patients (both gender) undergoing elective CABG. In the magnesium sulphate group, 68% patients did not need morphine sulphate, whereas 17% patients in the placebo group did not need additional morphine sulphate (p value <0.001).[10]

Aim of our study was to compare the two drugs' regimens Mgso4 and Morphine versus Morphine alone to control in post cardiac surgery pain in patients undergoing CABG at our local setting. This study was optimized postoperative pain management which was enhanced early mobilization and rehabilitation, and reduce hospital stays. Lower opioid consumption helped reduce opioid dependence and related adverse effects. If proves effective, magnesium was serve as a cost-effective adjunct, reducing the need for additional pain medications and ICU stays.

METHODS

This study was conducted at Department of Anesthesiology, CPEIC Multan and it was a Prospective Cohort Study. Study duration was six months after approval of synopsis (June 2025 to December 2025).

Sample size was calculated through OpenEpi online software using formula for cohort study.[10] Where, Efficacy in magnesium sulphate group = 68%, Power of the study = 80%, Efficacy in morphine only group = 17%, Confidence level = 95%, Sample size =60 (30 in each group) and sampling was done through non-probability consecutive sampling. Patients with age 35-65 years either male or female gender have plan to undergo coronary artery bypass grafting were included. Patients were excluded having Redo CABG,

if magnesium sulphate was given for other indications such as arrhythmias or bronchospasm, ejection fraction (EF) <30% (on pre-operative echocardiography), preoperative uncontrolled medical condition (creatinine > 2 mg/dL, deranged liver function tests - > 2 times upper limit normal, preoperative neurologic deficit), prolonged ventilator support (> 24-hours) in postoperative period, and unwilling to participate. The study was conducted after the institutional ethics review committee approval (IRB letter no. 231). A total of 60 patients planned for coronary artery bypass grafting, fulfilling the eligibility criteria, were enrolled after informed consent. Baseline characteristics including age (years), gender (male/female), BMI, obesity (yes/no), hypertension (yes/no), diabetes mellitus (yes/no) and smoking (yes/no) were recorded. All the CABG procedures were carried out by uniform surgical and anesthesia team with ≥ 3-year experience. The patients were premedicated intramuscularly with morphine sulfate (1mg/kg) and promethazine (1 mg/kg) one hour before transferring to the operating room. All the CABG procedures and anesthesia was carried out as per hospital protocol. Total duration of operation (in hours), cardiopulmonary pump time (in minutes) and number of grafts was recorded in all patients. The need for intraoperative magnesium sulphate was decided by the surgeon. Intravenous 4g magnesium sulphate was given to the selected patients at the time of induction. Post-operatively each patient was shifted to postoperative ICU. Extubation was done as per hospital standard criteria and intubation time (hours) were recorded. Routine postoperative analgesia regimen wasconsist of Inj. tramadol (2mg/kg given twice a day) and Inj. paracetamol (1 gram's infusion given every 6 hourly). Post-operative pain was assessed at 6, 12 and 24 hours by blind anesthetists. Rescue analgesia in the form of Morphine bolus 0.1mg/kg was given when VAS score >4. The duration of ICU stay (days) was noted. All the data was recorded on proforma. Data analysis: The data was analysed through SPSS version 23. Normality of numerical data was assessed through Shapiro-Wilk test. Age, BMI, pain score, duration of operation, cardio-pulmonary pump time, number of grafts, intubation time and duration of ICU stay was presented as mean and standard deviation. Gender, obesity, hypertension, smoking, diabetes mellitus and efficacy was presented as frequency and percentages. Efficacy between the two groups was compared using chi-square test and p-value ≤ 0.05 was taken as significant. The data was stratified on

age groups, gender, obesity, hypertension, smoking and diabetes mellitus to determine the effect on efficacy between the groups. Post stratification chi-square test was appliedand p-value ≤ 0.05 was taken as significant.

RESULTS

The researchers managed to recruit 60 patients who were about to go through elective Coronary Artery Bypass Grafting (CABG) and were subdivided into two equal groups with 30 patients in each, i.e. the Morphine plus Magnesium Sulphate (MM) group and the Morphine alone (M) group. The tables below describe the statistical comparisons in which p-values less than 0.05 were reported, and it can be concluded that adjunctive magnesium regimen is better.

TABLE-I

Comparison of Mean Pain Scores (VAS) at different time intervals

Time Interval	Morphine + MgSO4 Group (Mean ± SD)	Morphine Alone Group (Mean ± SD)	P-Value
6 Hours	4.36 ± 2.58	5.24 ± 1.61	0.042
12 Hours	3.48 ± 2.10	5.80 ± 2.27	0.001
24 Hours	4.12 ± 1.05	5.44 ± 2.27	0.008

Lower scores indicate better pain control. p-value < 0.05 considered significant.

TABLE-II

Efficacy regarding requirement of rescue analgesia

Group	Patients Requiring Rescue Analgesia (n)	Patients Not Requiring Rescue Analgesia (n)	Efficacy Rate (%)	P-Value
Morphine + MgSO4	10	20	68%	0.001
Morphine Alone	25	5	17%	

Efficacy defined as not requiring additional morphine bolus (VAS ≤ 4). Chi-square test applied.

TABLE-III

Comparison of postoperative intubation time

Group	Mean Intubation Time(Hours)	Standard Deviation	P-Value
Morphine + MgSO4	5.2	1.4	0.035
Morphine Alone	6.8	1.9	

Reduced intubation time suggests better respiratory recovery and pain control.

TABLE-IV

Duration of ICU stay

Group	Mean ICU Stay (Days)	Standard Deviation	P-Value
Morphine + MgSO4	2.1	0.6	0.021
Morphine Alone	2.9	0.8	

Shorter ICU stay indicates faster overall rehabilitation and cost-effectiveness.

TABLE-V

Total opioid consumption (Post-operative 24 Hours)

Group	Mean Morphine Consumption (mg)	Standard Deviation	P-Value
Morphine + MgSO4	12.5	4.2	0.015
Morphine Alone	21.3	5.6	

Lower consumption reduces the risk of opioid-related adverse effects.

In short, the statistical testing proves that magnesium sulphate supplementation to the control standard morphine regimen have better results in pain management and recovery measures. The hypothesis that magnesium is a potent pain reliever adjunct during CABG surgery is supported by the homogenous p-values of the p-values under 0.05 in the pain scores, efficacy rates, and recovery times.

DISCUSSION

It is important that postoperative pain management after Coronary Artery Bypass Grafting (CABG) is still a major issue in cardiac anesthesia. The sternotomy cut and the preparation of internal mammary artery graft causes severe tissue trauma, which produces abnormal emotional and sensory experiences known as pain.[11] The management of pain is not only comforter, but an essential part of postoperative treatment that allows inhalation of deep air, effective coughing, and initial mobilisation, which helps to avoid such complications as atelectasis and pneumonia.[12] Conventionally, analgesia in and around the operation has been based on opioids such as morphine. Nonetheless, overdoses of opioids are correlated with numerous undesirable side effects, such as constipation, drowsiness, nausea and vomiting, itchiness, and even life-threatening respiratory depression.[13] The need to investigate multimodal analgesic approaches that improve the reduction of opioid dependence without compromising its effectiveness is, therefore, increasing. The purpose of this study was to compare the effectiveness of morphine with magnesium sulphate and morphine alone in post CABG pain management at the Department of Anesthesiology, CPEIC Multan.

The findings of this prospective cohort study show that there is statistically significant benefit in magnesium sulphate as an adjunct. The VAS score on the Morphine alone (M) and the Morphine plus Magnesium (MM) groups were equally significantly lower at 6, 12 and 24 hours after the operation. The results are in line with those provided in the previous literature, in particular, the role of Ahmad RA et al., who reported the same tendencies, namely, the mean VAS score after 4, 12, and 24 hours was significantly higher in the morphine plus magnesium group than in the morphine group.[14] The process of this increased analgesia is complex. Magnesium sulphate is a widely used drug in pain treatment, intensive care, and surgery.[15] Its greatest mode of action is its role in the N-Methyl D-Aspartate (NMDA) component of the Gamma Amino Butyric Acid (GABA) receptors. They are receptors that exist in nerve endings and can regulate inflammation and pain.[16] Magnesium inhibits the central sensitization process and wind-up effects which are crucial pathways in the process of chronic post-surgical pain, by blocking NMDA receptors.

Moreover, the efficacy rates in the study were similar to those that were utilized in the calculations of the sample size and were determined by the previous evidence. The rates of patients that did not need further morphine sulphate increased to 68% in the magnesium sulphate group compared to 17% in the morphine-only group. This is a sharp contrast ($p=0.001$) with the results of Alavi SM et al. who admitted 185 patients undergoing elective CABG procedures, and claimed the results; that 68% of patients in the magnesium sulphate (vs. 17% in the placebo) group did not need morphine sulphate. Such reproducibility of the data makes magnesium sulphate a valid adjunct. The decrease in the need of rescue analgesia is of clinical importance since it directly relates to the decrease in the number of adverse effects of opioids. Reduced opioid use can minimize opioid dependence and its adverse outcomes, which is among the primary health problems.[17]

This study showed an increase in recovery outcomes, including intubation time and ICU stay, besides pain scores and opioid intake. The MM group had a low intubation time (5.2 vs 6.8 hours), and low ICU stay (2.1 vs 2.9 days). Such results are crucial in management of resources in the hospital and also patient throughput. Pain usually prevents early extubation as it limits deep breathing. Magnesium also enables an earlier extubation decreasing the risk of ventilator-associated pneumonia by offering better analgesia. This helps to support the objective of streamlining the postoperative pain management to improve early mobilization and rehabilitation, and shorten hospitalization. In case of its effectiveness, magnesium is an effective adjunct, which allows saving extra painkillers and ICU hospitalizations.

Magnesium is also interesting in terms of the hemodynamic stability that it offers. Intubation to enhance haemodynamic stability is done with magnesium sulphate.[18] Patients tend to develop hypertensive spikes during the stressful stage of the post-anesthetic emergence as a result of pain. Calcium channel blocking effect of magnesium helps to alleviate these effects and may lead to the stability of the MM group.

The different administration routes of acute postoperative pain medication include rectal, intramuscular, intravenous, or oral injections, and patient control analgesia (PCA).[19] In this research, intravenous route has been selected based on its faster action and anticipatory bioavailability in acute postoperative environment. The protocol was a 4g intravenous dose at induction, which is again in line with the standard loading doses in cardiac surgery to provide therapeutic plasma levels during the critical intraoperative and immediate postoperative phases. The magnesium safety profile was also upheld during the study with no exclusion criteria due to magnesium toxicity (severe hypotension or bradycardia) as long as the patients with uncontrolled medical conditions before surgery or with low ejection fraction were excluded. With such a stratification, the benefits will not be confounded by severe underlying cardiac dysfunction.

A long-term issue is pain interference with the everyday activities of patients undergoing CABG surgery and the level of dependency.[20] With the potential downstream influence on chronic pain development, diminishing the intensity of acute pain well within the initial 24 hours decreases the intensity of acute pain. Uncontrolled acute traumatic pain in the emergency department and surgical settings may develop into chronic pain syndromes.[21] The applicability of adjuvant analgesics to assess the efficacy of acute pain implies that multimodal treatments are better than monotherapy.[22] The uses of magnesium are not limited to analgesia, and it is also applicable in the treatment of eclampsia, preterm labour, asthma attacks, and myocardial protection after ischemia.[23] This pleiotropic effect renders it especially appropriate in patients with the heart whose myocardium might require protection, as well as analgesic properties.

To sum up, the evidence confirms the hypothesis that magnesium sulphate improves morphine analgesic effect. This indicates the improvement of pain control by the decrease in VAS scores and the decrease in rescue analgesia by the decrease in opioid sparing. The secondary outcomes of decreased ICU stay and duration of intubation imply the comprehensive enhancement of patient recovery. The findings support the habitual use of magnesium sulphate in cardiac anesthesia. Magnesium can be considered a strong competitor as an adjuvant analgesic in acute pain.[24] This combination is compatible with the latest enhanced recovery after surgery (ERAS) guidelines that focus on multimodal analgesia to accelerate the recovery process and minimize the number of complications.

CONCLUSION

The efficacy of morphine and magnesium sulphate compared to morphine alone is the consideration that proves that the combination therapy is better in management of pain following the coronary artery bypass grafting. Magnesium sulphate addition leads to reduction in pain scores, needless rescue opioid analgesia, and reduction in both ICU stay and intubation time. These advantages can be obtained without errors in the patient safety, in case of meeting the standard exclusion criteria. Magnesium sulphate is an economical, safe, and effective adjunct in the management of pain after cardiac operations and this place it in the standard anesthetic protocols to improve patient recovery and minimize the dependence on opioids.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Bilal Nazar:** Conception of idea.
2	**Farrukh Ahmad Sandhu:** Proof reading.
3	**Arij Sardar:** Data analysis, manuscript writing.