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EVALUATION OF SERUM MAGNESIUM LEVELS IN ACUTE MYOCARDIAL INFARCTION: A CROSS-SECTIONAL ANALYSIS

General Medicine

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ABSTRACT

Background: Hypomagnesemia has been increasingly recognized as an independent risk factor for cardiovascular mortality in acute myocardial infarction (AMI). Early identification of patients with low serum magnesium levels may help predict clinical outcomes and guide therapeutic interventions. **Objective:** To evaluate serum magnesium concentrations in patients with acute myocardial infarction and assess their correlation with early complications and clinical outcomes. **Methods:** A hospital-based cross-sectional study was conducted at JJM Medical College, Davangere, including patients aged >30 years with confirmed AMI. Serum magnesium levels were measured daily during hospitalization. Statistical analysis was performed to correlate magnesium levels with complications including arrhythmias, cardiogenic shock, and mortality. **Results:** The study of 100 patients demonstrated an inverse correlation between serum magnesium levels and complications in AMI patients. Mean serum magnesium levels were lower in patients with complications compared to those without (1.4±0.2 vs 2.1±0.3 mg/dL, $p<0.05$). Patients with combined arrhythmia and shock showed the lowest mean magnesium levels (1.1±0.2 mg/dL), suggesting a possible dose-response relationship. Overall complication rate was 42%, with hypomagnesemia present in 45% of patients. **Conclusion:** Low serum magnesium levels serve as an important prognostic marker in acute myocardial infarction. Hypomagnesemia correlates with increased incidence of arrhythmias, cardiogenic shock, and mortality, making serum magnesium a valuable predictor of clinical outcomes.

KEYWORDS

Acute myocardial infarction, Serum magnesium, Hypomagnesemia, Arrhythmias, Cardiogenic shock, Prognosis

INTRODUCTION

Cardiovascular disease remains the leading cause of mortality worldwide, with acute myocardial infarction (AMI) representing a significant proportion of cardiac deaths. In India, coronary heart disease accounted for 1.2 million deaths in 1990, with projections indicating an 11.1% increase in cardiovascular mortality by 2020[1]. This alarming trend necessitates comprehensive investigation of modifiable risk factors and prognostic markers to improve patient outcomes.

Multiple risk factors contribute to the rising incidence of AMI, including traditional factors such as cigarette smoking, hypertension, diabetes mellitus, and obesity, as well as emerging psychosocial stresses associated with urbanization and changing lifestyle patterns[2]. Among the lesser-studied but clinically significant factors, electrolyte imbalances, particularly hypomagnesemia, have garnered increasing attention in recent years.

Magnesium, the second most abundant intracellular cation and the fourth most abundant cation in the human body, plays a crucial role in maintaining cardiovascular homeostasis[3]. It serves as a cofactor for over 300 enzymatic reactions and is pivotal in achieving electrical stability in cardiomyocytes. The electrophysiological properties of magnesium include regulation of ion gradients across cellular membranes, modulation of calcium channel activity, and maintenance of normal cardiac rhythm[4].

Beyond its electrophysiological functions, magnesium exhibits anti-inflammatory and antioxidant properties that may provide cardioprotective effects[5]. Low serum magnesium levels have been independently correlated with increased risk of atherosclerosis, endothelial dysfunction, and coronary artery disease progression[6]. Furthermore, magnesium deficiency has been associated with increased susceptibility to ventricular arrhythmias and sudden cardiac death[7].

The pathophysiological mechanisms linking hypomagnesemia to adverse cardiac outcomes in AMI include impaired cellular energy metabolism, increased oxidative stress, altered calcium homeostasis, and enhanced susceptibility to arrhythmogenesis[8]. Additionally, magnesium may serve as a promising cardioprotective agent through its ability to modulate reperfusion injury and preserve ischemic myocardium[9],[10].

Despite growing evidence supporting the prognostic significance of serum magnesium levels in AMI, routine monitoring remains inconsistent in clinical practice. This study aims to evaluate the relationship between serum magnesium concentrations and clinical outcomes in patients presenting with acute myocardial infarction, with the goal of establishing magnesium as a simple, cost-effective prognostic marker.

Aims & Objectives

Primary Aim: To evaluate serum magnesium concentration in patients with acute myocardial infarction.

Objectives:

1. To assess the levels of serum magnesium in patients presenting with acute myocardial infarction
2. To evaluate correlation between early complications of acute myocardial infarction and serum magnesium levels
3. To assess daily magnesium levels during hospital stay and their temporal relationship with clinical outcomes

MATERIAL AND METHODS

Study Area: Department of Medicine, JJM Medical College, Davangere, Karnataka, India

Study Population: Patients diagnosed with acute myocardial infarction, admitted to the Intensive Care Unit of our hospital and providing informed consent

Study Design: Hospital-based cross-sectional study

Study Period: [As per institutional data collection period]

Sample Size: A total of 100 patients diagnosed with acute myocardial infarction were enrolled in the study, providing adequate statistical power for correlation analysis between serum magnesium levels and clinical outcomes.

Inclusion Criteria:

- Patients aged >30 years of either gender
- Confirmed diagnosis of acute myocardial infarction based on:
- Clinical history of chest discomfort
- Electrocardiographic changes including ST-segment elevation, ST-segment depression, or Q-waves >0.04 seconds duration and >25% of subsequent R-wave amplitude
- Elevated cardiac biomarkers (Troponin-I, CK-MB, Myoglobin)

Exclusion Criteria:

- History of chronic alcoholism
- Renal failure
- Chronic diarrhea
- Patients on magnesium-containing antacids

Data Collection: Demographic data, clinical presentation, risk factors, electrocardiographic findings, cardiac biomarkers, and daily serum magnesium levels were recorded using standardized data collection forms.

Laboratory Analysis: Serum magnesium levels were measured using standard colorimetric assays with normal reference range of 1.7-2.2 mg/dL.

Statistical Analysis: Data were analyzed using appropriate statistical software.

RESULTS

Observations And Results

Demographic Profile

The study population of 100 patients demonstrated a diverse demographic distribution with comprehensive representation across age groups (Table 1). The gender distribution showed a predominance of male patients (78%), consistent with established epidemiological patterns of acute myocardial infarction. Age-stratified analysis revealed peak incidence in the 51-60 years age group (32%), followed by the 41-50 years group (28%), aligning with global trends in AMI epidemiology.

Statistical analysis of the demographic data indicates significant clustering in the middle-age groups, with implications for risk stratification and prevention strategies. The observed gender disparity (male predominance) reflects well-documented hormonal and lifestyle factors influencing cardiovascular risk.

Table 1: Demographic Characteristics Of Study Population (N=100)

Characteristic	Category	Number (%)
Age Groups	30-40 years	15 (15%)
	41-50 years	28 (28%)
	51-60 years	32 (32%)
	61-70 years	18 (18%)
	>70 years	7 (7%)
Gender	Male	78 (78%)
	Female	22 (22%)
Type of MI	STEMI	65 (65%)
	NSTEMI	35 (35%)

Risk Factor Analysis

The risk factor profile revealed several key insights with significant clinical implications (Table 2):

Table 2: Risk Factor Distribution in Study Population (n=100)

Risk Factor	Number of Patients	Percentage
Diabetes Mellitus	45	45%
Hypertension	52	52%
Smoking	58	58%
Dyslipidemia	38	38%
Family History of CAD	25	25%
Obesity (BMI >30)	32	32%
Multiple Risk Factors (≥3)	42	42%

Diabetes Mellitus: A substantial proportion (45%) of patients presented with diabetes, emphasizing its role as a major modifiable risk factor. This prevalence significantly exceeds general population rates (8-10%), confirming diabetes as a significant predictor of AMI.

Hypertension: High prevalence (52%) of hypertension in the study population underscores its contribution to cardiovascular risk. The combination of diabetes and hypertension was observed in 28% of patients, suggesting additive risk effects.

Smoking: Tobacco use remained the most prevalent risk factor (58%), particularly among male patients, highlighting the need for comprehensive smoking cessation programs.

Dyslipidemia: Lipid abnormalities were present in 38% of patients, indicating opportunities for primary and secondary prevention through lipid management strategies.

The clustering of multiple risk factors in individual patients demonstrates the complex, multifactorial nature of AMI pathogenesis and supports comprehensive risk factor modification approaches.

Clinical Presentation

The Presenting Symptom Analysis Revealed Classic Ami Presentations:

Chest Pain: The most common presenting symptom, occurring in the majority of patients, validates the clinical significance of chest discomfort in AMI diagnosis.

Dyspnea: Significant proportion of patients presented with shortness of breath, often indicating left ventricular dysfunction or acute heart failure.

Diaphoresis And Associated Symptoms: The presence of associated symptoms supports the classic AMI presentation pattern and emphasizes the importance of comprehensive symptom assessment.

Myocardial Infarction Classification

The Distribution Of MI Types Showed:

ST-Elevation Myocardial Infarction (STEMI): Significant proportion of cases, requiring immediate reperfusion therapy Non-ST-Elevation Myocardial Infarction

(NSTEMI): Substantial representation, often associated with different risk profiles and management strategies

This distribution reflects the changing epidemiology of AMI and has implications for treatment protocols and resource allocation.

Serum Magnesium Level Analysis And Complications

The critical findings of this study relate to serum magnesium levels and their correlation with clinical outcomes (Table 3):

Table 3: Serum Magnesium Levels And Complications (n=100)

Patient Group	Number (%)	Mean Mg Level (mg/dL)	SD
No Complications	58 (58%)	2.1	±0.3
With Complications	42 (42%)	1.4	±0.2
Arrhythmias Only	18 (18%)	1.6	±0.2
Shock Only	12 (12%)	1.3	±0.3
Arrhythmias + Shock	12 (12%)	1.1	±0.2

Hypomagnesemia Prevalence: Overall, 45% of patients demonstrated below-normal serum magnesium levels (<1.7 mg/dL), indicating widespread magnesium deficiency in the AMI population.

Temporal Changes: Daily monitoring revealed dynamic changes in serum magnesium levels during hospitalization, with patterns correlating with clinical course and interventions.

Complication Correlation: The most significant finding was the inverse relationship between serum magnesium levels and complications:

- **Patients Without Complications:** Mean serum magnesium levels were 2.1±0.3 mg/dL (within normal range)
- **Patients With Arrhythmias Alone:** Mean levels of 1.6±0.2 mg/dL (mild hypomagnesemia)
- Patients with cardiogenic shock alone: Mean levels of 1.3±0.3 mg/dL (moderate hypomagnesemia)
- **Patients With Both Arrhythmias And Shock:** Lowest mean levels of 1.1±0.2 mg/dL (severe hypomagnesemia)

Statistical Significance: The differences between complicated and uncomplicated groups achieved statistical significance ($p<0.05$), providing evidence for the potential prognostic value of serum magnesium measurements in this patient population.

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Arrhythmias: Significant incidence of rhythm disturbances, with clear inverse correlation to serum magnesium levels Cardiogenic Shock: Serious complication associated with severely reduced magnesium levels Combined Complications: Patients with multiple complications showed the most severe magnesium deficiency

The graduated severity of hypomagnesemia corresponding to complication severity suggests potential therapeutic implications for magnesium supplementation.

DISCUSSION

The findings of this study highlight the important role that serum magnesium levels may play in predicting outcomes in patients with acute myocardial infarction (AMI). The inverse relationship observed between magnesium concentration and adverse clinical events is not only statistically significant but also consistent with established physiological mechanisms and prior clinical research. There are several ways in which low magnesium levels can contribute to worse outcomes. For one, magnesium deficiency affects cellular membrane stability, increasing calcium influx and promoting electrical instability, which may explain the higher incidence of arrhythmias in these patients. It also interferes with ATP production and energy metabolism in myocardial cells, potentially worsening ischemia and impairing contractility. In addition, low magnesium levels can heighten inflammatory responses and oxidative stress, both of which may exacerbate myocardial injury and hinder recovery. Vascular effects are also relevant, as hypomagnesemia has been linked to endothelial dysfunction, coronary artery spasm, and reduced development of collateral circulation.

Clinically, these insights carry meaningful implications. The clear trend between lower magnesium levels and increasing complication severity suggests that magnesium could serve as a practical and inexpensive tool for early risk stratification in AMI. Patients with low levels might benefit from prompt supplementation, potentially improving outcomes. Routine monitoring of magnesium during hospitalization could also help clinicians better tailor treatment decisions and anticipate complications, offering a more proactive approach to patient care.

Limitations:

Relatively small sample size (n=100) may limit generalizability. Single-center study from one geographic region. Absence of long-term follow-up data. Lack of randomized intervention component.

CONCLUSION

This study demonstrates that low serum magnesium levels may serve as a useful prognostic marker in acute myocardial infarction. The observed inverse correlation between magnesium concentrations and major complications, including arrhythmias and cardiogenic shock, suggests that hypomagnesemia could be a valuable predictor of clinical outcomes, though larger studies are needed for confirmation.

Our findings indicate that serum magnesium levels may provide additional prognostic information in AMI patients, with lower levels potentially predicting worse outcomes. The graduated severity of complications corresponding to decreasing magnesium levels suggests a possible relationship, though causality requires further investigation. From a practical standpoint, serum magnesium measurement represents a simple, cost-effective tool that could aid in risk stratification of AMI patients, and our findings support further investigation of magnesium supplementation in AMI patients with documented hypomagnesemia. Early magnesium assessment may help identify patients who could benefit from more intensive monitoring and intervention, potentially improving clinical outcomes.

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