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ASSOCIATION BETWEEN ADMISSION SERUM MAGNESIUM LEVELS AND VENTRICULAR ARRHYTHMIAS IN ACUTE MYOCARDIAL INFARCTION: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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ABSTRACT

Background: Acute myocardial infarction (AMI) is a major cardiovascular emergency and is commonly associated with ventricular arrhythmias such as ventricular tachycardia (VT) and ventricular fibrillation (VF). Magnesium plays an important role in maintaining normal cardiac electrical activity, and low serum magnesium may increase the risk of arrhythmias during AMI.

Aim: To study the association between low serum magnesium levels and ventricular arrhythmias in patients with acute myocardial infarction.

Materials and Methods: This descriptive cross-sectional study was conducted among 75 patients with acute myocardial infarction admitted within 24 hours of symptom onset at a tertiary care hospital in Tamil Nadu. Serum magnesium levels were measured at admission, Day 2, and discharge. Patients were monitored for ventricular arrhythmias during hospital stay. Hypomagnesemia was defined as serum magnesium level <1.7 mg/dL. Statistical analysis was performed using descriptive statistics, chi-square test, Fisher's exact test, and multivariable logistic regression.

Results: The mean age of the study population was 55.35 ± 12.84 years, and 68.0% were males. STEMI accounted for 70.7% of cases. Low serum magnesium at admission was present in 36.0% of patients. Ventricular arrhythmias occurred in 24.0% of patients, with VT in 18.7% and VF in 5.3%. VT/VF was more common in patients with low magnesium levels (29.6%) compared to patients with normal magnesium levels (20.8%), but this difference was not statistically significant (p=0.412). Multivariable logistic regression showed hypertension as an independent predictor of VT/VF (Adjusted OR 4.148, p=0.023).

Conclusion: Hypomagnesemia was common among AMI patients. Patients with low serum magnesium showed higher occurrence of ventricular arrhythmias, although statistical significance was not achieved. Hypertension was independently associated with VT/VF. Routine monitoring of serum magnesium may help in identifying high-risk AMI patients.

Keywords: Acute myocardial infarction, serum magnesium, hypomagnesemia, ventricular tachycardia, ventricular fibrillation, arrhythmia.

1. Introduction

Acute myocardial infarction (AMI) remains one of the leading causes of morbidity and mortality worldwide despite major advances in diagnosis and treatment. Ventricular arrhythmias, especially ventricular tachycardia (VT) and ventricular fibrillation (VF), are among the most serious complications of AMI and contribute significantly to early in-hospital mortality. Early identification of factors associated with ventricular arrhythmias is therefore important in improving patient outcomes. Recent studies have shown that electrolyte abnormalities may play an important role in the development of arrhythmias during the acute phase of myocardial infarction.[1,2]

Magnesium is an essential intracellular cation involved in several physiological processes including myocardial membrane stabilization, regulation of ion transport, and maintenance of normal cardiac electrical activity. It acts as a natural calcium antagonist and helps regulate sodium-potassium ATPase activity, thereby maintaining normal myocardial excitability and conduction.[3,4] Magnesium also has important vascular effects including vasodilatation, endothelial stabilization, and reduction of platelet aggregation, which may influence outcomes in acute coronary syndromes.[5,6]

Hypomagnesemia is commonly observed in patients with acute myocardial infarction. The reduction in serum magnesium levels during AMI may occur due to stress-induced catecholamine release, intracellular magnesium shift, renal loss, poor nutritional status, and use of certain medications.[7] Several studies have reported that low serum magnesium levels are associated with increased risk of ventricular arrhythmias and adverse cardiac outcomes in AMI patients.[8,9,10]

Mizuguchi et al. reported that admission serum magnesium has prognostic significance in AMI patients complicated by malignant ventricular arrhythmias.[11] Rahman et al. also observed that low magnesium levels were associated with increased arrhythmia occurrence in AMI patients.[12] Similarly, Taha et al. reported a high prevalence of hypomagnesemia among AMI patients and its association with intra-hospital complications.[13]

Although earlier studies evaluated magnesium supplementation as a routine treatment in AMI, more recent evidence suggests that serum magnesium may be useful as a prognostic marker and a potentially modifiable risk factor rather than a universal therapeutic intervention.[14,15] Salaminia et al., in a systematic review and meta-analysis, reported that magnesium supplementation may reduce arrhythmias after acute coronary syndrome.[16] Szapary et al. also demonstrated the beneficial effect of magnesium in reducing reperfusion arrhythmias in STEMI patients undergoing primary PCI.[17]

Despite improvements in reperfusion therapy and critical cardiac care, ventricular arrhythmias continue to remain an important cause of mortality in AMI patients.[18,19] Therefore, identifying inexpensive and easily measurable biomarkers such as serum magnesium may help in early risk stratification and monitoring of high-risk patients. Since limited Indian studies are available regarding the association between serum magnesium levels and ventricular arrhythmias in AMI patients, the present study was undertaken to evaluate the relationship between low serum magnesium levels and ventricular arrhythmias in patients with acute myocardial infarction admitted to a tertiary care hospital.

AIM: To study the association between low serum magnesium levels and ventricular arrhythmias in patients with acute myocardial infarction.

OBJECTIVES

1. To measure serum magnesium levels in patients with acute myocardial infarction.
2. To determine the incidence of ventricular arrhythmias in patients with acute myocardial infarction.
3. To analyze the association between serum magnesium levels and ventricular arrhythmias in AMI patients.
4. To evaluate the relationship between serum magnesium levels and in-hospital outcomes in AMI patients.

MATERIALS AND METHODS

Study Design: Descriptive cross-sectional study.

Study Setting: The study was conducted in the Department of General Medicine at Sree Balaji Medical College and Hospital from June 2024 to December 2025.

Study Population: The study included 75 patients diagnosed with acute myocardial infarction and admitted within 24 hours of symptom onset.

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Inclusion Criteria

1. Patients aged 18 years and above
2. Patients diagnosed with acute myocardial infarction based on clinical findings, ECG changes, and cardiac biomarkers
3. Patients admitted within 24 hours of symptom onset

Exclusion Criteria

1. Patients with chronic kidney disease or on dialysis
2. Patients with known electrolyte imbalance other than magnesium
3. Patients receiving magnesium supplementation before admission
4. Patients with inherited arrhythmia syndromes
5. Patients with significant valvular heart disease

Data Collection Procedure

Detailed clinical history, demographic details, cardiovascular risk factors, and treatment details were recorded for all patients.
Serum magnesium levels were measured at:

- Admission
- Day 2 of hospitalization
- At discharge

Patients were continuously monitored for ventricular arrhythmias during hospital stay using ECG monitoring.
Hypomagnesemia was defined as serum magnesium level <1.7 mg/dL.

Outcome Measures

Primary Outcome

Occurrence of ventricular arrhythmias (VT/VF) during hospitalization.

Secondary Outcomes

1. In-hospital mortality
2. Length of hospital stay
3. Requirement of advanced cardiac interventions such as defibrillation and anti-arrhythmic therapy

Statistical Analysis

Data were entered and analyzed using SPSS software version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. Chi-square test, Fisher's exact test, and independent t-test were used where appropriate. Multivariable logistic regression analysis was performed to identify independent predictors of ventricular arrhythmias. A p-value <0.05 was considered statistically significant.

RESULTS

Study Population

A total of 75 patients with confirmed acute myocardial infarction (AMI) admitted within 24 hours of symptom onset were included in the present study. The mean age of the study population was 55.35 ± 12.84 years, with an age range of 29–83 years. Male patients constituted the majority of the study population (68.0%). STEMI was the predominant type of AMI and accounted for 70.7% of cases. Hypertension was present in 44.0% of patients, diabetes mellitus in 40.0%, and smoking history in 36.0% of patients. The mean time from symptom onset to hospital admission was 6.02 ± 3.95 hours.
The baseline demographic and clinical characteristics of the study population are summarized in **Table 1**.
Figure 1. : Sex distribution of study participants (n = 75)
Figure 2 : Distribution of AMI subtype

Distribution of AMI Type and Management Strategy

Among the study population, STEMI constituted 53 (70.7%) cases, while NSTEMI accounted for 22 (29.3%) cases. Regarding treatment strategy, PPCI was the most commonly used management approach followed by thrombolysis.
The distribution of AMI subtype and management strategies is shown in **Table 2**.
Figure 3 Distribution of management strategies among AMI patients

Serum Magnesium Profile

The mean serum magnesium level at admission was 1.80 ± 0.24 mg/dL, with values ranging from 1.36 to 2.27 mg/dL. Low serum magnesium (<1.7 mg/dL) was observed in 27 (36.0%) patients.
Serial serum magnesium measurements showed a gradual increase during hospitalization. Mean magnesium levels increased from 1.80 mg/dL at admission to 1.88 mg/dL on Day 2 and 1.89 mg/dL at discharge.
The serum magnesium profile during hospitalization is presented in **Table 3**.
Figure 4 : Histogram showing distribution of admission serum magnesium levels
Figure 5 : Trend of mean serum magnesium during hospitalization

Incidence and Pattern of Ventricular Arrhythmias

Ventricular arrhythmias occurred in 18 out of 75 patients, giving an overall incidence of 24.0%. Ventricular tachycardia (VT) was observed in 14 (18.7%) patients, while ventricular fibrillation (VF) occurred in 4 (5.3%) patients.
The incidence and pattern of ventricular arrhythmias are summarized in **Table 4**.
Figure 6 : Incidence and type of ventricular arrhythmias

Comparison Between Patients With and Without VT/VF

Patients were categorized into:

- No VT/VF group (n = 57)
- VT/VF group (n = 18)

Comparison of demographic characteristics, cardiovascular risk factors, AMI subtype, and serum magnesium status between the two groups is shown in **Table 5**.
Hypertension showed a statistically significant association with ventricular arrhythmias (p = 0.008). Other variables including age, sex, diabetes mellitus, smoking history, STEMI subtype, time to admission, and low magnesium status did not show statistically significant differences.
Patients with low serum magnesium demonstrated a higher proportion of VT/VF (44.4%) compared to patients with normal magnesium levels (33.3%), although this difference was not statistically significant.

Relationship Between Admission Magnesium and VT/VF

Among patients with low serum magnesium (<1.7 mg/dL), ventricular arrhythmias occurred in 29.6% of cases compared to 20.8% among patients with normal magnesium levels.
Effect estimates showed:

- Risk Ratio (RR): 1.42
- Odds Ratio (OR): 1.60
- Fisher's exact p-value: 0.412

These findings suggest a trend toward increased arrhythmia risk among patients with hypomagnesemia, although statistical significance was not achieved.

Multivariable Logistic Regression Analysis

A multivariable logistic regression model was constructed to identify independent predictors of ventricular arrhythmias. The model included admission magnesium

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status, age, sex, AMI subtype, diabetes mellitus, hypertension, and time to admission.

Hypertension remained independently associated with VT/VF after adjustment (Adjusted OR 4.148; 95% CI 1.213–14.187; p = 0.023). Low serum magnesium demonstrated increased odds for VT/VF but did not achieve statistical significance.

The multivariable logistic regression analysis is shown in **Table 6**.

Figure 7 : Forest plot of adjusted odds ratios for predictors of VT/VF

Secondary Outcomes

The mean length of hospital stay in the overall cohort was 6.25 ± 1.65 days. Patients with VT/VF had slightly longer hospital stay compared to patients without VT/VF.Overall in-hospital mortality was 8.0%. Mortality was higher among patients who developed VT/VF (16.7%) compared to those without VT/VF (5.3%).

Advanced cardiac interventions including defibrillation and anti-arrhythmic therapy were more frequently required among VT/VF patients.

Secondary outcomes according to VT/VF status and admission magnesium status are summarized in **Table 7**.

Tables

Table 1. Baseline demographic and clinical characteristics of the study population (n = 75)

Characteristic	Value
Age (years), Mean ± SD	55.35 ± 12.84
Male sex, n (%)	51 (68.0%)
STEMI, n (%)	53 (70.7%)
Hypertension, n (%)	33 (44.0%)
Diabetes mellitus, n (%)	30 (40.0%)
Smoking history, n (%)	27 (36.0%)
Time to admission (hours), Mean ± SD	6.02 ± 3.95
Admission magnesium (mg/dL), Mean ± SD	1.80 ± 0.24
Low magnesium (<1.7 mg/dL), n (%)	27 (36.0%)
Length of hospital stay (days), Mean ± SD	6.25 ± 1.65
In-hospital mortality, n (%)	6 (8.0%)

Table 2. Distribution of AMI type and management strategy among study participants

Variable	n (%)
STEMI	53 (70.7%)
NSTEMI	22 (29.3%)
PPCI	27 (36.0%)
Thrombolysis	20 (26.7%)
Conservative management	12 (16.0%)
Early invasive strategy	10 (13.3%)
Medical management	6 (8.0%)

Table 3. Serum magnesium profile during hospitalization

Time Point	Mean (mg/dL)	SD	Minimum	Maximum
Admission	1.80	0.24	1.36	2.27
Day 2	1.88	0.26	1.18	2.40
Discharge	1.89	0.27	1.10	2.55

Table 4. Incidence and pattern of ventricular arrhythmias in AMI patients

Arrhythmia Type	n	%
No VT/VF	57	76.0
Ventricular tachycardia (VT)	14	18.7
Ventricular fibrillation (VF)	4	5.3

Table 5. Comparison of clinical characteristics between patients with and without VT/VF

Variable	No VT/VF (n=57)	VT/VF (n=18)	p-value
Age (years), Mean ± SD	55.23 ± 13.30	55.72 ± 11.62	0.88
Male sex, n (%)	39 (68.4%)	12 (66.7%)	1.00
STEMI, n (%)	39 (68.4%)	14 (77.8%)	0.558
Hypertension, n (%)	20 (35.1%)	13 (72.2%)	0.008*
Diabetes mellitus, n (%)	22 (38.6%)	8 (44.4%)	0.784
Smoking history, n (%)	20 (35.1%)	7 (38.9%)	0.782
Time to admission (hours), Mean ± SD	5.89 ± 3.97	6.44 ± 3.94	0.617
Low magnesium, n (%)	19 (33.3%)	8 (44.4%)	0.412

***Statistically significant**

Table 6. Multivariable logistic regression analysis for predictors of VT/VF

Predictor	Adjusted OR	95% CI	p-value
Low magnesium (<1.7 mg/dL)	1.649	0.518–5.25	0.398
Age	1.001	0.957–1.047	0.968
Male sex	1.296	0.359–4.674	0.692
STEMI	1.817	0.457–7.227	0.396
Diabetes mellitus	1.099	0.330–3.662	0.878
Hypertension	4.148	1.213–14.187	0.023*
Time to admission	1.043	0.918–1.185	0.519

***Statistically significant**

Table 7. Secondary outcomes according to VT/VF status and admission magnesium status

Variable	VT/VF Absent	VT/VF Present	Normal Mg	Low Mg
Number of patients	57	18	48	27
Mean LOS (days)	6.16 ± 1.61	6.51 ± 1.79	6.23 ± 1.62	6.28 ± 1.74
Mortality, n (%)	3 (5.3%)	3 (16.7%)	5 (10.4%)	1 (3.7%)
VT/VF occurrence, n (%)	—	—	10 (20.8%)	8 (29.6%)
Defibrillation required	0	9	—	—
Antiarrhythmic use	0	14	—	—

Figures

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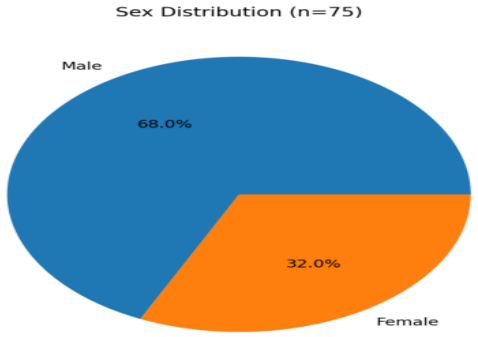

Figure 1. Sex distribution of study participants (n = 75)

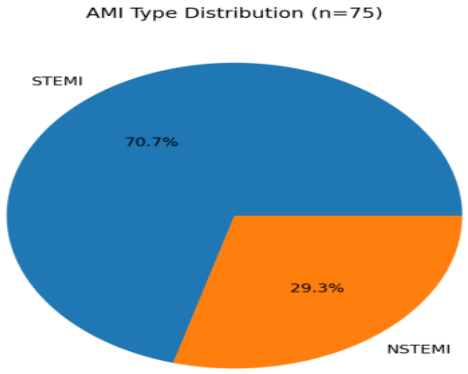

Figure 2. Distribution of AMI subtype among study participants (n = 75)

Figure 3. Distribution of management strategies among AMI patients (n = 75)

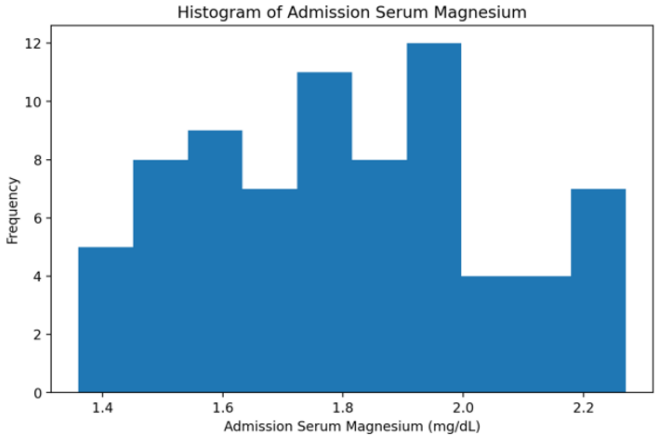

Figure 4. Histogram showing distribution of admission serum magnesium levels among AMI patients

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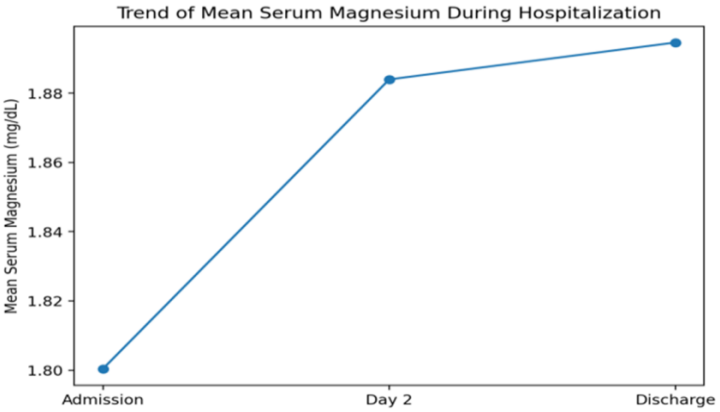

Figure 5. Trend of mean serum magnesium levels during hospitalization

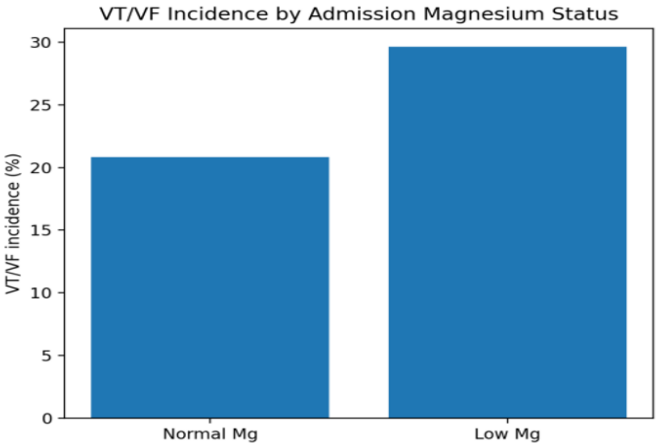

Figure 6. Incidence and pattern of ventricular arrhythmias among AMI patients

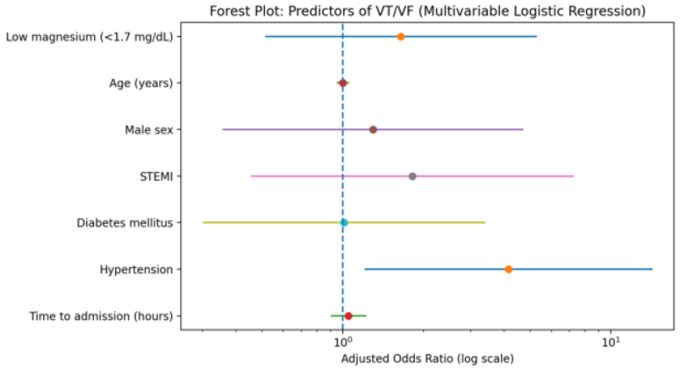

Figure 7. Forest plot showing adjusted odds ratios for predictors of ventricular arrhythmias (VT/VF)

DISCUSSION

The present study was conducted to evaluate the association between serum magnesium levels and ventricular arrhythmias in patients with acute myocardial infarction (AMI). A total of 75 AMI patients admitted within 24 hours of symptom onset were included in the study. The important findings of the present study were that hypomagnesemia was common among AMI patients, ventricular arrhythmias occurred in nearly one-fourth of patients, and hypertension emerged as an independent predictor of VT/VF.In the present study, the mean age of the patients was 55.35 ± 12.84 years, and male patients constituted the majority of the study population. STEMI was more common than NSTEMI. These findings are similar to the observations reported by Barnett et al. and Zhao et al., who reported that AMI commonly affects middle-aged and elderly males and that STEMI remains a major presentation of acute coronary syndrome.[15,22]

Low serum magnesium at admission was observed in 36.0% of patients in the present study. Similar findings were reported by Bangi et al., Wahid et al., and Singh et al., who observed reduced serum magnesium levels in a significant proportion of AMI patients.[2,3,4] Taha et al. also reported a high prevalence of hypomagnesemia among patients with acute myocardial infarction and showed its association with intra-hospital complications.[19]

Magnesium plays an important role in maintaining myocardial electrical stability. de Baaij et al. explained that magnesium regulates ion transport, membrane stability, and myocardial conduction.[16] Kolte et al. also stated that magnesium acts as a natural calcium antagonist and influences cardiac electrophysiology and vascular function.[17] Therefore, reduced magnesium levels may increase myocardial electrical instability and predispose patients to ventricular arrhythmias.In the present study, ventricular arrhythmias occurred in 24.0% of patients, with VT being more common than VF. Similar observations were reported by Sharma et al., who found that ventricular arrhythmias are common during the acute phase of myocardial infarction and are associated with increased morbidity and mortality.[5] Masuda et al. also reported that VT/VF during AMI continues to remain an important predictor of adverse outcomes despite advances in reperfusion therapy.[13]

Patients with low serum magnesium showed a higher occurrence of VT/VF compared to patients with normal magnesium levels. Although statistical significance was not achieved, the findings suggest a trend toward increased arrhythmia risk in patients with hypomagnesemia. Similar findings were reported by Mizuguchi et al., who demonstrated that admission serum magnesium has prognostic significance in AMI patients complicated by malignant ventricular arrhythmias.[6] Rahman et al. also observed an association between low magnesium levels and arrhythmia occurrence in AMI patients.[18]

The lack of statistical significance in the present study may be due to the relatively small sample size and limited number of arrhythmia events. Ventricular arrhythmias in AMI are multifactorial and are influenced by infarct size, reperfusion status, autonomic imbalance, and other electrolyte disturbances in addition to magnesium levels.

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An important finding in the present study was that hypertension emerged as an independent predictor of VT/VF on multivariable logistic regression analysis. Chrysant et al. reported that hypertension is associated with cardiovascular remodeling and increased arrhythmic susceptibility.[10] Hypertension may contribute to left ventricular hypertrophy, myocardial ischemia, and increased electrical instability, thereby increasing the risk of ventricular arrhythmias during AMI.

The present study also showed that patients with VT/VF had higher in-hospital mortality and slightly longer hospital stay compared to patients without arrhythmias. Similar findings were reported by Masuda et al. and Sharma et al., who observed that ventricular arrhythmias are associated with poor short-term outcomes and increased mortality in AMI patients.[5,13]

Recent studies have also evaluated the role of magnesium supplementation in acute coronary syndrome. Salaminia et al. reported in a systematic review and meta-analysis that magnesium supplementation may reduce arrhythmias after acute coronary syndrome.[11] Szapary et al. also demonstrated beneficial effects of magnesium in reducing reperfusion arrhythmias in STEMI patients undergoing PPCI.[7] However, earlier large studies such as the MAGIC trial did not demonstrate consistent mortality benefit with routine magnesium administration in all AMI patients.[22] Therefore, current evidence suggests that magnesium monitoring may be more useful for identifying high-risk patients rather than routine supplementation in all cases.

The present study has certain important strengths and clinical relevance. Limited Indian studies have evaluated the association between serum magnesium levels and ventricular arrhythmias specifically among AMI patients in a tertiary care setting. The present study assessed serial serum magnesium measurements along with clinical outcomes and multivariable analysis of arrhythmic predictors. The study also evaluated the relationship between hypomagnesemia, VT/VF occurrence, mortality, and hospital stay in a real-world inpatient population. Although statistical significance was not achieved for magnesium and VT/VF association, the observed trend toward increased arrhythmia risk highlights the possible clinical importance of serum magnesium monitoring in AMI patients. Since serum magnesium estimation is inexpensive, easily available, and routinely feasible in most Indian hospitals, early identification and correction of hypomagnesemia may help improve monitoring and risk stratification in high-risk patients with acute myocardial infarction.

CONCLUSION

Hypomagnesemia was common among patients with acute myocardial infarction in the present study. Ventricular arrhythmias occurred in nearly one-fourth of patients, with VT being more common than VF. Patients with low serum magnesium levels showed higher occurrence of ventricular arrhythmias, although statistical significance was not achieved. Hypertension emerged as an independent predictor of VT/VF.

Routine monitoring of serum magnesium may help in early identification of high-risk AMI patients and may assist in better risk stratification and management during hospitalization.

RECOMMENDATIONS

1. Routine serum magnesium estimation should be considered in all patients admitted with acute myocardial infarction.
2. Patients with low serum magnesium should be closely monitored for ventricular arrhythmias during hospitalization.
3. Early correction of electrolyte abnormalities may help reduce arrhythmic complications in high-risk AMI patients.
4. Larger multicentric studies with bigger sample size are recommended to further evaluate the relationship between hypomagnesemia and ventricular arrhythmias.
5. Future studies should also assess the role of magnesium supplementation in patients with documented hypomagnesemia.

LIMITATIONS

1. The study was conducted in a single tertiary care center.
2. The sample size was relatively small.
3. Serum magnesium may not accurately reflect intracellular magnesium levels.
4. Other electrolytes such as potassium and calcium were not included in multivariable analysis.
5. Magnesium supplementation details were not separately evaluated.

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CONFLICT OF INTEREST: The authors declare that there is no conflict of interest related to this study.

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