E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.01.590

Research Article

Serum Magnesium Levels and Its Relationship with Immediate Outcome in Patients with Non-St Elevation Myocardial Infarction

Jabin John Jacob[1], Sue Ann Zachariah[2*], Durga Padmanabhan[3]
[1]Junior Resident, Department of General Medicine, Government Medical College, Kottayam, Kerala, India - 686008
[2*]Associate Professor, Department of General Medicine, Government Medical College, Kottayam, Kerala, India - 686008
[3]Assistant Professor, Department of General Medicine, Government Medical College, Kottayam, Kerala, India – 686008
Corresponding Author: Dr Sue Ann Zachariah
Associate Professor, Department of General Medicine, Government Medical College, Kottayam, Kerala,
Email: zachsadr@gmail.com
Received: 15.04.26, Revised: 11.05.26, Accepted: 17.06.26

ABSTRACT
Non ST elevation myocardial infarction (NSTEMI) is a major subset of acute coronary syndrome (ACS), with significant early morbidity. Magnesium is important for myocardial electrical stability, calcium regulation, and vascular tone. Altered serum magnesium levels during acute ischemia may influence early clinical outcomes. Data relating serum magnesium levels to immediate in-hospital complications in NSTEMI are limited.
Objectives 1.To estimate serum magnesium levels in patients with NSTEMI. **2.** To assess association between admission serum magnesium levels and early in-hospital outcomes including arrhythmia, recurrent angina, cardiac failure, prolonged hospital stay, and mortality.
Methods: A hospital-based cross-sectional study was conducted among 200 patients with NSTEMI. Serum magnesium levels at admission were categorized as hypomagnesemia (<1.8 mg/dL), normomagnesemia (1.8–2.3 mg/dL), and hypermagnesemia (>2.3 mg/dL). In-hospital complications were monitored. Statistical analysis was carried out with $p < 0.05$ considered significant.
Results: Among 200 patients, 56.5% were males. Mean serum magnesium was 1.87 ± 0.22 mg/dL. 32.5% of patients had hypomagnesemia, 65% had normomagnesemia, and 2.5% had hypermagnesemia. Patients with arrhythmia had significantly lower mean magnesium levels ($p = 0.002$). Cardiac failure ($p = 0.025$), recurrent angina ($p < 0.001$) and prolonged hospital stay ($p = 0.001$) were significantly associated with hypomagnesemia. Mortality was higher in patients with hypomagnesemia, with no statistical significance ($p = 0.283$).
Conclusion: Admission hypomagnesemia was significantly associated with immediate in-hospital complications in NSTEMI. Routine magnesium estimation may aid in early risk stratification. Further prospective studies are required to establish causal relationships.

Keywords: NSTEMI, Hypomagnesemia, Arrhythmia, Cardiac Failure.

INTRODUCTION

Cardiovascular diseases (CVDs) continue to be the foremost cause of mortality and morbidity worldwide and pose a significant challenge to public health systems, particularly in low- and middle-income countries such as India. According to global estimates, ischemic heart disease alone accounts for nearly half of all cardiovascular deaths and contributes substantially to disability-adjusted life years lost[6-8]. In India, the burden of coronary artery disease (CAD) has increased rapidly over the past few decades due to urbanization, lifestyle changes, aging population, and a rising prevalence of metabolic risk factors such as diabetes mellitus and hypertension[9–12].

Acute coronary syndrome (ACS) represents a spectrum of clinical conditions resulting from acute myocardial ischemia and includes ST-elevation myocardial infarction (STEMI), non–ST-elevation myocardial infarction (NSTEMI), and unstable angina[1,13–15]. NSTEMI has emerged as a predominant form of ACS in contemporary clinical practice, largely due to improved diagnostic sensitivity with the introduction of high-sensitivity cardiac troponin assays[1]. Although NSTEMI lacks the classic electrocardiographic ST-segment elevation, it is associated with significant short-term and

long-term adverse outcomes comparable to STEMI[14–18].

Immediate outcomes in patients with NSTEMI, such as recurrent angina, malignant arrhythmias, acute heart failure, prolonged hospital stay, and early mortality, remain major determinants of prognosis and healthcare utilization[14,16,19–21]. Risk stratification in NSTEMI traditionally relies on clinical assessment, electrocardiographic changes, cardiac biomarkers, and imaging studies[1]. However, increasing evidence suggests that metabolic and electrolyte disturbances play a crucial role in modulating myocardial injury and clinical outcomes during the acute phase of myocardial infarction[13–16,22–26].

Among various electrolytes, magnesium has gained particular interest because of its fundamental role in cardiovascular physiology and pathophysiology. Magnesium is the second most abundant intracellular cation and is involved in more than 300 enzymatic reactions essential for cellular metabolism, protein synthesis, neuromuscular conduction, and cardiovascular function[2,23,24,27-31]. In the heart, magnesium is critical for maintaining electrical stability, regulating vascular tone, and modulating myocardial contractility through its interaction with calcium and potassium ions[25,28,23,30].

Patients with acute myocardial infarction are especially vulnerable to disturbances in magnesium homeostasis[24,26]. Stress-related catecholamine release, intracellular shifts, renal losses, reduced dietary intake, and associated comorbidities contribute to hypomagnesemia during the acute phase of infarction[24,26]. Several studies have demonstrated lower serum magnesium levels in patients with acute myocardial infarction, particularly among those who develop complications such as ventricular arrhythmias and heart failure[24,26].

Despite substantial literature on magnesium in STEMI, data specifically addressing serum magnesium levels and immediate outcomes in NSTEMI remain limited, especially in the Indian context. Given regional differences in dietary magnesium intake, socioeconomic factors, and disease patterns, locally generated evidence is essential. This study therefore aims to estimate serum magnesium levels in patients with NSTEMI and evaluate their relationship with immediate in-hospital outcomes, with the goal of identifying a simple, inexpensive prognostic marker that may aid early risk stratification and improve patient management.

Objectives

1. To estimate serum Magnesium levels in patients admitted with non-ST elevation myocardial infarction.
2. To determine the relationship between serum magnesium levels and immediate complications in Non-ST elevation Myocardial Infarction.

MATERIALS AND METHODS

This was a cross sectional study conducted in Govt Medical College, Kottayam, in the Department of General Medicine for a period of 12 months. A sample size of 200 was taken after sample size calculations determined an n = 188. After receiving IRB clearance, informed consent was taken from the patients who met the following inclusion criteria- All cases of acute coronary syndromes of age more than 18 years with 1. Having a Troponin at least one value above the 99th percentile upper reference limit at least once, OR an ECG having new horizontal or down sloping ST depression $\geq$0.05 mV in two contiguous leads OR T wave inversion $\geq$0.1 mV in two contiguous leads with a prominent R wave OR R/S ratio >1 without any ST elevation. Patients who met the following were excluded from the study – 1. Patients with known comorbidities like CKD, myocarditis, myopathy, recent trauma, diarrhoea and malnutrition. 2. Patient on any drugs that may affect the levels of electrolytes in the body or on any supplements of electrolytes including vitamin D.3.Chronic alcoholism 4. STEMI and evolved STEMI 5. Non-ST Elevation myocardial infarction managed with interventional procedures. Consecutive sampling was used to enrol the patients. A semi structured proforma was used for data collection. Details such as sociodemographic characters, medical history, addictions and complications were collected. In all subjects, Serum Magnesium, Troponin I and electrocardiogram were obtained. All enrolled subjects were followed up for three days.. Serum Magnesium levels at admission were measured. These patients were managed conservatively with heparin injection for 3 days, dual ant platelets, statins, nitrates and beta blockers. If they were free of further episodes of chest pain for continuous 48 hrs after admission, they were discharged to follow up in cardiology OPD. Outcome was measured in terms of duration of hospital stay,

development of further episodes of chest pain, development of arrhythmia during 3 days, and mortality.

Outcome Parameters

Patients admitted with NSTEMI in medical wards were managed conservatively with 48 hours heparin infusion and dual anti platelets, statins, nitrates and beta blockers. Patients were followed up for 3 days and outcome on day 3 was assessed. Patients were discharged on day 3 if their unfractionated heparin infusion was completed and they were chest pain free for 48 hrs. Complications assessed were further angina, arrhythmia and cardiac failure. Patients not discharged by day 3 were categorized as having prolonged hospital stay. Cardiac failure was considered if the patient developed any form of left ventricular dysfunction secondary to NSTEMI. Mortality was considered if any subject died due to NSTEMI related cardiac causes.

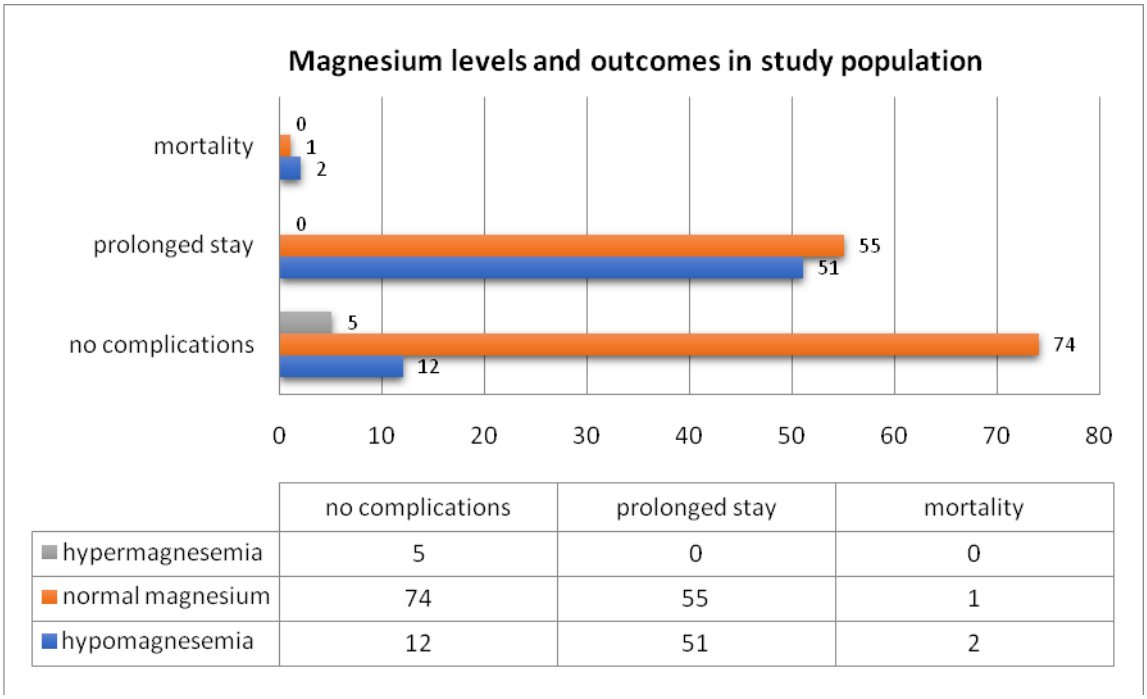
Data Management and Statistical Analysis

Data was entered in an excel spread sheet and SPSS version 25.0 was used for statistical analysis[33].All qualitative variables were expressed as frequency and percentage and all quantitative variables as mean and standard deviation. The relationship between outcome of NSTEMI and serum Magnesium levels was assessed using Chi square test.

RESULTS

Table 1: Serum Magnesium Levels in Study Population

Magnesium levels Serum Mg (mg/dL)	N	Percentage
Hypomagnesemia< 1.8	65	32.5%
Normomagnesemia1.8 – 2.3	130	65%
Hypermagnesemia> 2.3	5	2.5%
Total	200	100%



	no complications	prolonged stay	mortality
hypermagnesemia	5	0	0
normal magnesium	74	55	1
hypomagnesemia	12	51	2

Fig 1: Outcomes in the Study Population

In the total study population of 200, 65 (32.5%) had hypomagnesemia, 130 (65%) had normomagnesemia, and 5 (2.5%) had hypermagnesemia. Of the 65 patients with hypomagnesemia, 12 (18.5%) were discharged without complications, 51 (78.5%) had prolonged hospital stay, and 2 (3.1%) expired. Among the 130 patients with normomagnesemia, 74 (56.9%) were discharged without complications, 55 (42.3%) had prolonged hospital stay, and 1 (0.8%) expired. Of the 5 patients with hypermagnesemia, all (100%) were discharged without complications, with no prolonged hospital stay or mortality.

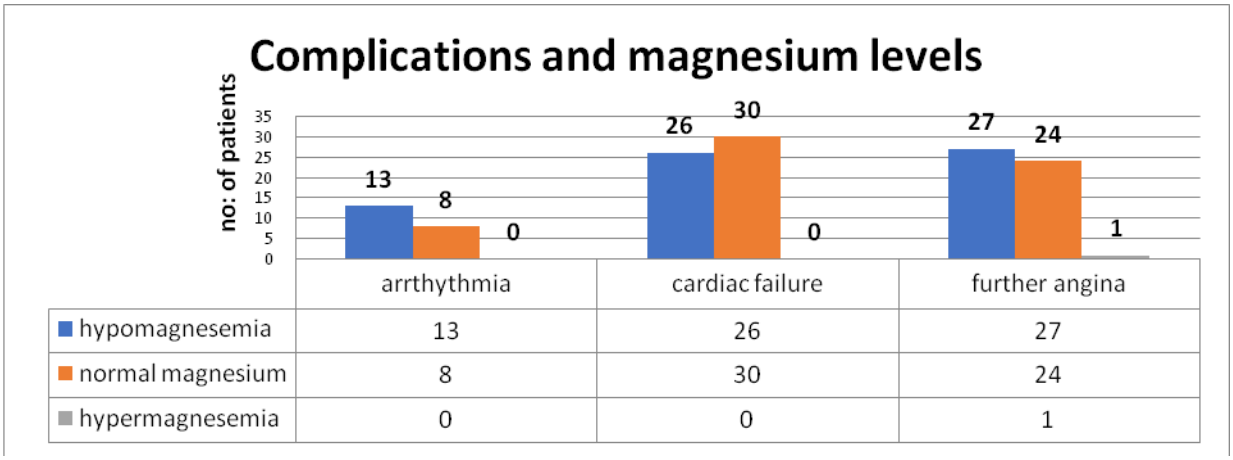


Fig 2: Complications and Magnesium Levels of the Study Population

52 patients experienced further episodes of angina - 27 (51.9%) had hypomagnesemia, 24 (46.2%) had normomagnesemia, and 1 (1.9%) had hypermagnesemia. 21 patients developed new arrhythmia, 13 (61.9%) had hypomagnesemia and 8 (38.1%) had normomagnesemia. No arrhythmia events were observed among patients with hypermagnesemia. The higher numbers of arrhythmia with hypomagnesemia suggests a strong association between reduced serum magnesium levels and electrical instability during NSTEMI. 56 patients developed cardiac failure: 26 (46.4%) had hypomagnesemia and 30 (53.6%) had normomagnesemia. Hypermagnesemia was not seen. cardiac failure was distributed across both low and normal magnesium levels. Across all complications, hypomagnesemia was prominently represented, particularly in patients with arrhythmia and further angina.

Association of serum Magnesium levels with various outcomes

Table 3: Association of Serum Magnesium Levels with Various Outcomes

Outcome	**Status**	**Serum Mg level**				**P value**
		<1.8		**≥1.8**		
		n	**(%)**	**n**	**(%)**	
Arrythmia	No	52	(29.05)	127	(70.95)	0.005*
	Yes	13	(61.90)	8	(38.10)	
Cardiac failure	No	39	(27.08)	105	(72.92)	0.012*
	Yes	26	(46.43)	30	(53.57)	
Further Angina	No	38	(25.68)	110	(74.32)	0.001*
	Yes	27	(51.92)	25	(48.08)	
Prolonged hospital stay	No	41	(25.79)	118	(74.21)	<0.001*
	Yes	24	(58.54)	17	(41.46)	
Mortality	No	63	(31.98)	134	(68.02)	0.247
	Yes	2	(66.67)	1	(33.33)	

*P value <0.05, Fisher's Exact test

A statistically significant association was seen between serum magnesium levels and new arrhythmia (p = 0.005). Hypomagnesemia patients <1.8 mg/dL developed arrhythmia compared to those with levels ≥1.8 mg/dL. Cardiac failureshowed a significant association with serum magnesium levels (p = 0.012). With hypomagnesemia having a higher frequency of cardiac failure. Further angina was significantly associated with serum magnesium levels (p = 0.001), being higher among patients with magnesium levels <1.8 mg/dL. Prolonged hospital stay had a significant association with hypomagnesemia (p < 0.001). A greater proportion of patients with magnesium <1.8 mg/dL experienced prolonged hospitalization.

Mortality did not show a statistically significant association with serum magnesium levels (p = 0.247).

DISCUSSION

The present study evaluated the association between serum magnesium levels and early in-hospital outcomes among NSTEMI patients. The findings demonstrate that lower serum magnesium levels are significantly associated with arrhythmia, cardiac failure, recurrent angina, and prolonged hospital stay. These findings are in concordance with previous studies that have highlighted the role of hypomagnesemia in adverse cardiac outcomes during acute coronary syndromes.

The mean serum magnesium level in the study population was 1.87 ± 0.22 mg/dL with 32.5**%** of patients demonstrating hypomagnesemia (<1.8 mg/dL). These findings are comparable with observations of RB Singh et al. which showed patients with patients with acute myocardial infarction had significantly lower serum magnesium levels compared to controls. Our study was in concordance with the parent study[32].

This finding aligns with previous studies that have reported reduced serum magnesium levels during acute myocardial ischemia[2,31,32,39]. Dyckner et al. demonstrated that magnesium levels decline during the acute phase of myocardial infarction and are associated with ventricular arrhythmias[23]. Similar findings were reported in subsequent observational studies where hypomagnesemia was common in acute coronary events.

Arrhythmia developed in 21 (10.5%) patients during hospitalization. Patients who developed arrhythmia had significantly lower serum magnesium (1.73 ± 0.23 mg/dL) compared to those without arrhythmia(1.89 ± 0.22 mg/dL) with (p = 0.002). This finding is consistent with earlier studies (Dyckner et al., Rasmussen et al.) which demonstrated that hypomagnesemia predisposes to ventricular arrhythmias in acute myocardial infarction. Rasmussen et al. reported significantly higher arrhythmic events in patients with low magnesium levels[23,26].

Cardiac failure developed in 55 patients (27.5%). Cardiac failure was significantly associated with lower serum magnesium levels(1.81 ± 0.20 mg/dL) compared to those without cardiac failure (1.89 ± 0.23 mg/dL), with p = 0.025. Shechter et al. have shown that magnesium deficiency impairs myocardial contractility and promotes intracellular calcium overload, thereby increasing susceptibility to ventricular dysfunction. The findings of the present study are in agreement with these observations and suggest that low magnesium may exacerbate myocardial dysfunction during acute ischemia[31].

Recurrent angina during hospitalization was observed among patients with significantly lower serum magnesium levels. The mean magnesium level among patients with further angina was 1.78 ± 0.21 mg/dL compared to 1.90 ± 0.22 mg/dL in those without recurrent angina (p < 0.001). These findings were consistent with prior studies conducted by Satake et al. which reported severity of magnesium deficiency correlated with frequency of variant angina attacks[40].

Prolonged Hospital Stay

In the present study, prolonged hospital stay was seen among patients who developed complications: arrhythmia, cardiac failure, or recurrent angina. Patients with prolonged hospitalization had a mean serum magnesium level of 1.77 ± 0.20 mg/dL compared to 1.90 ± 0.22 mg/dL among those discharged without complications (p <0.001). This outcome was secondary to the development of complications. The association likely reflects the increased frequency of complications among hypomagnesemic patients rather than a direct independent effect of magnesium on length of stay. The complications on which the study focussed on were further episodes of angina, arrhythmia and cardiac failure. Similar associations between low magnesium and increased in-hospital morbidity have been reported in prior ACS cohorts[41].

Mortality

Although mortality was numerically higher among patients with lower magnesium levels compared to survivors, the association did not reach statistical significance ($p = 0.283$). The lack of significance in the present study may be attributable to the low mortality rate (1.5%) and limited statistical power.

Overall Interpretation

The present study demonstrates that lower serum magnesium levels are significantly associated with arrhythmia, cardiac failure, recurrent angina, and prolonged hospitalization in NSTEMI patients. These findings are consistent with previous literature and reinforce the pathophysiological importance of magnesium in myocardial ischemia and electrical stability[23,31,32].

CONCLUSION

This cross-sectional study evaluated the association between admission serum magnesium levels and early in-hospital outcomes in 200 patients with NSTEMI. The mean serum magnesium level was 1.87 ± 0.22 mg/dL, and hypomagnesemia was observed in 32.5% of patients. Lower serum magnesium levels were significantly associated with arrhythmia, cardiac failure, recurrent angina, and prolonged hospital stay. Patients who developed complications had significantly lower mean magnesium levels compared to those without complications. Although mortality was numerically higher among patients with low magnesium levels, the association was not statistically significant. These findings suggest that reduced admission serum magnesium is associated with increased early in-hospital morbidity in NSTEMI. Given its low cost and availability, serum magnesium estimation may aid in early risk stratification and closer monitoring. However, as this was a cross-sectional study, causality cannot be established, and further prospective studies are required.

ACKNOWLEDGEMENTS

1. Department of General Medicine, Government Medical College, Kottayam.
2. Department of Cardiology, Government Medical College, Kottayam.

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