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"The Role of Hypomagnesemia as Prognostic Indicator in Patients with St Elevation Myocardial Infarction"

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KEYWORDS

Hypomagnesemia, ST-Elevation Myocardial Infarction, Prognostic Indicator, Killip Classification, Arrhythmias, Magnesium Supplementation.

ABSTRACT:

Background: Cardiovascular diseases, particularly acute myocardial infarction (AMI), remain a leading cause of mortality worldwide. ST-elevation myocardial infarction (STEMI) is a severe form of AMI associated with significant morbidity and mortality. Hypomagnesemia has been increasingly recognized as a potential prognostic marker in STEMI patients, influencing cardiac function and patient outcomes. However, its role remains underexplored in clinical settings.

Aim: To determine whether hypomagnesemia at admission serves as a prognostic indicator in patients with STEMI and to evaluate its association with disease severity and clinical outcomes.

Materials and Methods: This prospective cohort study included 110 patients diagnosed with STEMI based on American Heart Association (AHA) criteria. Serum magnesium levels were measured at admission, and patients were categorized into hypomagnesemia and normal magnesium groups. Clinical severity was assessed using Killip classification, and outcomes, including mortality, arrhythmias, and recovery rates, were evaluated at a 30-day follow-up. Statistical analysis was performed using SPSS v23.0, with $p<0.05$ considered significant.

Results: The study cohort had a mean age of 60.3 years, with a male predominance (58.2%). Hypomagnesemia was significantly associated with higher Killip class severity (9.1% in class 3 vs. 1.8% in normal magnesium, $p<0.05$). At 30-day follow-up, recovery was significantly higher in patients with normal magnesium levels (54.5%) compared to those with hypomagnesemia (23.6%), while mortality was also higher in the hypomagnesemia group (3.6%). Additionally, hypomagnesemia was linked to increased arrhythmias, including ventricular tachycardia (10.9%)."

Conclusion: Hypomagnesemia is significantly associated with worse outcomes in STEMI patients, including higher disease severity, increased arrhythmia risk, and lower recovery rates. Routine assessment of magnesium levels in STEMI patients may help in early risk stratification and targeted therapeutic interventions. Further research is required to explore the potential benefits of magnesium supplementation in improving clinical outcomes.

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Introduction:

Cardiovascular disease is a leading cause of death both in India and globally. Compared to the Western population, Indians have a higher predisposition to coronary artery disease (CAD), with symptoms manifesting approximately a decade earlier.[1] Acute coronary syndrome (ACS) is one of the most common presentations of CAD and it includes unstable angina, ST-segment elevation myocardial infarction (STEMI), and non- STEMI (NSTEMI).[2]

ST-segment elevation myocardial infarction (STEMI) has become increasingly prevalent in the Indian population, with its early onset drawing attention to clinical research aimed at improving diagnosis and prognosis. Globally, acute myocardial infarction remains the leading cause of death, accounting for over 2.5 million hospitalizations each year.[3]

In India, cardiovascular diseases (CVDs) have significantly increased in recent decades, with acute myocardial infarction (AMI) becoming a major cause of mortality, particularly among younger adults.[4,5] Urbanization, sedentary lifestyles, tobacco use, and the rising prevalence of risk factors such as hypertension and diabetes have all contributed to this epidemiological shift.[6] Moreover, genetic predispositions and distinct environmental factors specific to the Indian subcontinent may further impact the susceptibility and clinical presentation of AMI in younger individuals.[7]

Magnesium is a vital electrolyte involved in the pathophysiology of STEMI. While several studies have explored the association between magnesium levels and STEMI, the available evidence remains limited and inconclusive. Hypomagnesemia, or low serum magnesium levels, has gained attention as a key factor influencing the prognosis of various cardiovascular diseases. In the context of STEMI—a condition caused by severe coronary artery blockage—magnesium deficiency has been associated with poorer clinical outcomes. Magnesium plays a crucial role in maintaining myocardial function, ensuring electrical stability, and regulating vascular tone. This has sparked interest in investigating hypomagnesemia as a prognostic marker in STEMI patients, as it may contribute to arrhythmias, heightened complication risks, and adverse outcomes. A deeper understanding of magnesium's role in STEMI could help refine therapeutic strategies and enhance patient management.[8,9]

Hence this study is aimed to determine the hypomagnesemia at admission can be used as prognostic indicator in patients with ST elevation myocardial infarction.

Material & Method:

The study was conducted at Aarupadai Veedu Medical College and Hospital in various departments, including General Medicine OPD/IPD, Cardiac OPD, ICCU, and Master Health Checkups. It followed a prospective cohort design with 110 participants diagnosed with STEMI based on AHA guidelines. Patients aged 18-80 years were included, while those with chronic kidney disease, persistent vomiting or diarrhea, long-term diuretic use, recent intravenous magnesium therapy, pregnancy, lactation, or inability to provide consent were excluded. The study spanned 18 months, with a sample size of 93 calculated using statistical formulas, and an additional 10% added to account for follow-up losses.

Participants were categorized into two groups based on their magnesium levels at admission: hypomagnesemia and normal magnesium. Clinical data, hemodynamic parameters (blood pressure, heart rate, and cardiac output), and echocardiographic measurements (ejection fraction and left ventricular function) were collected. The severity of STEMI was assessed using the Killip classification. A 30-day follow-up was conducted to evaluate outcomes, including clinical improvement, mortality, recurrent myocardial infarction, heart failure, arrhythmias, and mechanical or functional complications.

Statistical analysis involved descriptive statistics to summarize demographic and clinical characteristics. The prevalence of hypomagnesemia was calculated with a 95% confidence interval. Chi-square or Fisher's exact test was used for categorical variables, while t-tests or Mann-Whitney U tests were applied to continuous variables. Logistic regression models assessed the association between hypomagnesemia and adverse outcomes, with odds ratios (OR) and confidence intervals (CI) adjusted for confounders such as age, gender, and comorbidities. Statistical significance was set at $p<0.05$, and SPSS v23.0 was used for analysis.

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Result: Present study included total of 110 patients fulfilling inclusion criteria, with mean age of 60.3yrs. Among them 58.2% were male and 41.8% were female patients with marginal male preponderance.

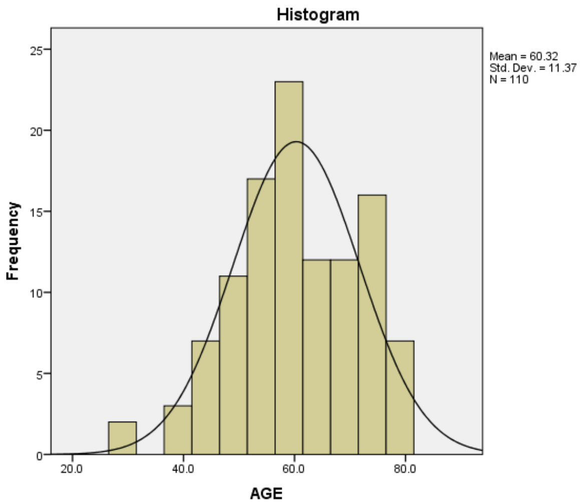

Figure 1: Showing mean age of patients

Table 1: Distribution agewise between the groups

		Hypo Mg (<1.6mg/dL)		N. Mg (1.6-2.4mg/dL)		
		Count	N %	Count	N %	Chi-square (p-value)
Age Group	18-30 yrs	0	0.0%	1	1.8%	1.23 (0.29)
	31-45 yrs	5	9.1%	5	9.1%	
	46-60 yrs	27	49.1%	24	43.6%	
	61-80 yrs	23	41.8%	25	45.5%	

There is no significant difference in distribution according to age between the groups.(p>0.05)

Table 2: Showing the distribution according to various parameters

		Count	N %
Occupation	Conductor	2	1.8%
	Daily wage labour	15	13.6%
	Driver	9	8.2%
	Farmer	17	15.5%
	Homemaker	28	25.5%
	Mechanic	2	1.8%
	Retired	23	20.9%
	Self employed	4	3.6%
	Software	3	2.7%
	Teacher	7	6.4%
Complaints	Breathlessness on Exertion	37	33.6%
	Chestpain	91	82.7%
	Palpitations	30	27.2%
	Sweating	1	0.9%
	Syncope	7	6.4%
ECG	AWMI	67	60.9%
	IWMI	39	35.5%

	LWMI	4	3.6%
2D ECHO	EF 40%	11	10.0 %
	MILD LVD	6	5.5%
	Moderate LVD	13	11.8 %
	Severe LVD	2	1.8%
	Normal	78	70.9 %
Systemic Examination	RALES +	24	21.8 %
	S1S2+	86	78.2 %
KILLIP classification	Class 1.0	86	78.2 %
	Class 2.0	18	16.4 %
	Class 3.0	6	5.5%
30days Follow-up	Atrial Fibrillation	11	10.0 %
	Death	2	1.8%
	Heart Failure	6	5.5%
	Recovered	43	39.1 %
	SVT	4	3.6%
	VPCS	32	29.1 %
	VT	12	10.9 %

Among the patients, 25.5% were homemakers, 20.9% were retired, 15.5% were farmer, 13.6% were daily wage labour. The most common presentation was found to be chest pain in 82.7% cases, followed by breathlessness on exertion in 33.6%, palpitation in 27.2%, syncope in 6.4% and sweating in 0.9% cases. ECG showing the presence of AWMI in 60.9%, followed with 35.5% showing IWMI and 3.6% with LWMI. Among patients 2D ECHO showing the abnormal findings in 29.1% of the cases, with most common findings as moderate left ventricular dysfunction in 11.8% cases, followed by EF 40%, moderate LVD in 5.5% and severe LVD in 1.8% cases. Based on KILLIP classification, majority were in class 1 (78.2%) followed by 16.4% in class 2 and 5.5% in class 3.

Table 3: Association of KILLIP classification with magnesium level

		Hypo Mg (<1.6mg/dL)		N. Mg (1.6-2.4mg/dL)		Chi-square (p-value)
		Count	N %	Count	N %	
KILLIP classification	Class 1.0	41	74.5%	45	81.8%	2.85 (0.05)*
	Class 2.0	9	16.4%	9	16.4%	
	Class 3.0	5	9.1%	1	1.8%	
30 days Follow-up	Atrial Fibrillation	9	16.4%	2	3.6%	16.84 (0.01)*
	Death	2	3.6%	0	0.0%	
	Heart Failure	4	7.3%	2	3.6%	
	Recovered	13	23.6%	30	54.5%	
	SVT	2	3.6%	2	3.6%	

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	VPCS	16	29.1%	16	29.1%	
	VT	9	16.4%	3	5.5%	

There is significant association between the 30 day follow-up outcome with magnesium levels among patients. Death was significantly higher among the cases with hypomagnesemia (3.6%). Also the patients with normal magnesium recovered (54.5%) compared to hypomagnesemia (23.6%). ($p<0.05$)

Discussion:

The Killip classification is a well-established clinical grading system used to assess heart failure severity in acute myocardial infarction (AMI), playing a crucial role in evaluating STEMI severity. Studies indicate that lower magnesium levels may be associated with higher Killip classes, reflecting poorer cardiac function and an increased risk of adverse outcomes. Recognizing this relationship is essential for effective risk stratification and optimizing treatment approaches in STEMI patients. This study aims to evaluate the prognostic significance of hypomagnesemia in STEMI patients by assessing its correlation with the Killip classification and 30-day outcomes. By analyzing clinical presentations, electrocardiographic findings, and echocardiographic parameters, we explore the role of serum magnesium levels in predicting recovery, complications, and mortality in STEMI patients. Identifying hypomagnesemia as a potential risk factor can guide clinicians in early interventions, including magnesium supplementation, to improve patient outcomes.

Present study included total of 110 patients fulfilling inclusion criteria, with mean age of 60.3yrs. Among them 58.2% were male and 41.8% were female patients with marginal male preponderance. Among the patients, 25.5% were homemakers, 20.9% were retired, 15.5% were farmer, 13.6% were daily wage labour. In similar to present study Aher AA et al., documented with mean age of participants was 55.74±9.27 years, with a predominance of males (75.81%). Systemic hypertension (40.32%) and diabetes mellitus (32.26%) were the most common risk factors, and all patients presented with chest pain on admission. Anterior wall MI was the most frequent type, followed by inferior wall MI. [10] Another study by Baset MA et al., found Chest pain was the most common presenting symptom, reported by all patients, with accompanying sweating (60%), breathlessness (64%), and palpitations (50%). Smoking was the most prevalent risk factor (70%), followed by diabetes (36%) and hypertension (30%).[11]Another study by Jaffery M et al., 77 were males and 23 females, with mean ages of 54.78 ± 8.82 years for males and 53.64 ± 10.82 years for females. [12]

The most common presentation was found to be chest pain in 82.7% cases, followed by breathlessness on exertion in 33.6%, palpitation in 27.2%, syncope in 6.4% and sweating in 0.9% cases, ECG showing the presence of AWMI in 60.9%, followed with 35.5% showing IWMI and 3.6% with LWMI. Among patients 2D ECHO showing the abnormal findings in 29.1% of the cases, with most common findings as moderate left ventricular dysfunction in 11.8% cases, followed by EF 40%, moderate LVD in 5.5% and severe LVD in 1.8% cases.

In similar to present study Aher AA et al., anterior wall MI was the most frequent type, followed by inferior wall MI. [10] Another study by Baset MA et al., found Anterior wall MI was the most frequent type (42%), and arrhythmias occurred in 52% of patients, predominantly in those with anterior wall MI (57.7%).[11] In study by Vedamanickam R et al., 73% of acute myocardial infarction (AMI) patients were over 41 years old, with 53% presenting with anterior wall MI, 40% with inferior wall MI, and 7% with anterolateral MI.[13] Jaffery M et al., types of acute myocardial infarction (AMI) observed included inferior wall (29%), lateral wall (22%), anteroseptal (16%), anterolateral (9%), right ventricular (13%), and posterior wall (9%).[12]

In present study, based on KILLIP classification, majority were in class 1 (78.2%) followed by 16.4% in class 2 and 5.5% in class 3. 30 days follow-up showing the 39.1% patients recovered. Other findings included the patients with ventricular premature complexes in 29.1%, ventricular tachycardia in 10.9%, 5.5% with heart failure and 3.6% with supraventricular tachycardia. Mortality was seen in 1.8% of the cases. On comparison of the KILLIP classification with magnesium levels, there is significant hypomagnesemia among the cases with class 3 grade (9.1%) compared to the patients with normal magnesium (1.8%).($p<0.05$) Showing the significant association between the severity of based on KILLIP classification in AMI with magnesium levels. There is significant association between the 30 day follow-up outcome with magnesium levels among patients. Death was significantly higher among the cases with hypomagnesemia (3.6%). Also the patients with normal magnesium recovered (54.5%) compared to hypomagnesemia (23.6%). ($p<0.05$)

Vedamanickam R et al., found that the mean serum magnesium level in AMI patients was significantly lower (1.23±0.98 mg/dL) compared to the control group (2.12±0.68 mg/dL). The findings suggest that hypomagnesemia is prevalent in AMI patients and their comorbidities, indicating that magnesium supplementation could potentially improve patient outcomes. [13] Chrysant SG et al., Hypomagnesemia is linked to severe cardiac arrhythmias and worsened hypertension. The findings suggest that magnesium deficiency is associated with an increased risk of cardiovascular diseases, heart failure, arrhythmias, and hypertension, highlighting the importance of maintaining normal magnesium levels to prevent these conditions.[14] Another study by Segev A et al., "Patients with low serum magnesium (sMg) levels (median 1.7 mg/dL) were older, less likely to be male, and had higher rates of comorbidities such as diabetes, hypertension, and atrial fibrillation compared to those with normal/high sMg levels (median 2.0 mg/dL). Kaplan–Meier analysis revealed a significantly higher cumulative death probability at 4 years in the low sMg group (34% vs. 22%). Multivariable analysis, adjusted for confounders, showed that low sMg was independently associated with a 24% increased risk of long-term mortality ($p < 0.001$). The findings highlight low sMg as a significant prognostic factor for long-term survival in NSTEMI patients."[15]

In similar study by Verma R et al., they "revealed that patients with arrhythmias had significantly lower mean serum magnesium levels (1.71±0.38 mg/dL, p=0.031) compared to those without arrhythmias (1.88±0.32 mg/dL). Similarly, mean potassium levels were lower in patients with arrhythmias (4.02±0.43 mmol/L, p=0.006) compared to those without arrhythmias (3.59±0.63 mmol/L).[16] Also in study by Aher AA et al., although serum magnesium levels were lower in patients who expired (1.80±0.42) compared to survivors (1.96±0.35), the difference was not statistically significant ($p>0.05$). While low serum magnesium levels were linked to complications like cardiogenic shock, congestive cardiac failure, and complete heart block, these associations were not statistically[10] Study by Baset MA et al., found that "on day 1, the mean serum magnesium level was 1.86±0.39, rising to 2.26±0.5 by day 5. Patients with arrhythmias had significantly lower serum magnesium levels (1.65±0.26 on day 1 and 1.98±0.25 on day 5) compared to those without arrhythmias (2.05±0.41 on day 1 and 2.48±0.52 on day 5; $p<0.001$). Premature ventricular contractions (42.5%) were the most common type of arrhythmia. The study concluded that serum magnesium levels are significantly lower in AMI patients who develop arrhythmias."[11]

Conclusion: The study highlights hypomagnesemia as a significant prognostic marker in STEMI patients. Among 110 patients, most were male, with a mean age of 60.3 years, and chest pain was the predominant symptom. Hypomagnesemia was associated with more severe clinical presentations, particularly in Killip class 3 patients. At the 30-day follow-up, recovery was significantly higher in patients with normal magnesium levels (54.5%) compared to those with hypomagnesemia (23.6%), while mortality was also higher in the hypomagnesemia group (3.6%). These findings suggest that routine magnesium assessment in STEMI patients may aid in risk stratification and early intervention, with further research needed on the potential benefits of magnesium supplementation.

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Conflict of interest: Nil

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