Association of Serum Magnesium and Myocardial Infarction in Patients at a Tertiary Health Care Centre in Chengalpattu District

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ABSTRACT

Background: Magnesium is a key intracellular cation involved in myocardial electrophysiology, vascular tone regulation, and platelet function. Hypomagnesemia has been involved in the pathogenesis of myocardial infarction (MI).

Objective: To evaluate the association between serum magnesium levels and myocardial infarction.

Methods: A hospital-based case–control study was conducted among 50 participants, including 25 MI cases and 25 controls. Serum magnesium was estimated using the VITROS 5600 Integrated System. Hypomagnesemia was defined as <1.7 mg/dL. Statistical analysis included mean comparison and odds ratio calculation.

Results: The mean serum magnesium level in MI cases was 1.66 mg/dL, compared to 1.97 mg/dL in controls. Hypomagnesemia was present in 64% of cases and 20% of controls. The calculated odds ratio was 7.1, indicating a strong association.

Conclusion: Serum magnesium levels were significantly lower in MI patients, and hypomagnesemia showed a strong association with myocardial infarction.

Keywords: Serum Magnesium; Hypomagnesemia; Myocardial Infarction; Acute Coronary Syndrome; Cardiovascular Risk; Biomarker; Case–Control Study; Arrhythmia.

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INTRODUCTION

Magnesium has been involved in the pathogenesis of acute myocardial infarction and its complications like arrhythmias. Magnesium ions are considered important for the maintenance of the functional integrity of the myocardium. Magnesium has significant cardiovascular roles including vasomotor tone, endothelial dysfunction and cardiac electrophysiology.Magnesium plays a role in myocardial energy homeostasis, oxidative stress reduction and platelet aggregation inhibition which translates to antithrombotic effects [1,7]. Additionally

by regulating intracellular calcium, it helps stabilise myocardial activity and reduces arrhythmogenic potential. Hypomagnesemia is linked to atherosclerosis, dyslipidemia and greater coronary plaque formation [1,4]. Magnesium at cellular level helps maintain the ionic gradients through Na+/k+-ATPase activity.

Hypomagnesemia promotes vasopasm, membrane stability, catecholamine release and intracellular calcium and sodium accumulation which predisposes to arrythmias. [8,9]. Magnesium acts as a physiological antagonist of calcium by inhibiting L-Type calcium channels preventing calcium overload in cardiomyocytes. Clinical studies show that the levels of serum magnesium drop low at 48 hours after Acute Myocardial Infarction (AMI) and is lower in patients who had complications which correlates with an increased rate of arrhythmia and adverse cardiovascular events [1,2]. Taking into account the mechanisms described above, the study of serum magnesium in patients with Acute Myocardial Infarction may provide valuable insights into the contribution of magnesium to aetiology of heart disease or indicator of severity. Therefore this study aims to compare the levels of serum magnesium between patients of Acute Myocardial Infarction with age and sex matched controls to look for association between hyomagnesemia and Acute Myocardial Infarction in a tertiary health care centre.

MATERIALS AND METHODS:

Study Design and Setting:

This case control study was conducted in Department of Clinical Biochemistry and General Medicine of Karpaga Vinayaga Institute of Medical Sciences and Research Centre in Maduranthagam, Chengalpattu district. The study was conducted over a period of one year.

Study Population:

A total of 50 participants were included in the study and divided into two groups

Cases (n=25): Patients diagnosed with myocardial infarction.

Controls (n=25): Individuals who attended the OPD for routine general health check-up with no evidence of Myocardial Infarction.

Inclusion Criteria:

Patients above 18 years of age with Symptoms suggestive of Myocardial Infarction proven by cardiac enzymes or Electrocardiogram.

Exclusion Criteria:

Patients with Liver Cirrhosis , Chronic Renal Failure , Protracted Vomiting , Chronic Diarrhoea, on magnesium compound antacids , anti cancer drugs were excluded from the study.

Sample Collection:

Venous blood was collected from cases within 24 hours of admission after taking aseptic precautions. Following the blood collection, serum was separated via centrifugation and analysed. Hemolysed samples were excluded. Serum Magnesium levels were measured by VITROS 5600 integerated system using dry chemistry photometry method based on xyilidyl blue dye binding protein.

The normal refference range for serum magnesium was considered to be 1.7-2.2 mg/dL as described in Tietz Textbook of Clinical Chemistry and Molecular Diagnostics.

Statistical Analysis:

Statistical analysis of all the data were perfomed using the statistical package for social sciences (SPSS) version 29.0. The serum magnesium levels were analyzed and the result was shown in mean ± standard deviation (SD). The difference of means between cases and controls were analyzed using unpaired t test and categorical values were analyzed using chi square test for categorical variables like presence of hypomagnesemia were analyzed as number and percentages. The association between hypomagnesemia and myocardial infarction was evaluated using chi-square test and the odds ratio (OR) with 95% confidence interval (CI) was calculated to determine the strength of association. A p value of <0.05 was considered as a statistically significant difference.

Ethical Consideration:

Institutional ethics committee approval was obtained prior to the study.

(IEC Ref No - KIMS/PG/05/19.02.2025)

Written informed consent was obtained from all participants and patient confidentiality was strictly maintained.

RESULTS

A total of 50 participants (25 MI cases and 25 Controls - individuals attending Outpatient Department for routine health check up) were included in the study. The mean age of cases was similar to that of controls and the difference in the age distribution of cases and controls was not significant

implying a low likelihood of confounding.Males exceeded females in both the cases and controls, but the sex distribution was similar between the two groups, and the selection bias was thus less of a concern.MI Cases demonstrated significantly lower serum magnesium level (1.66 ± 0.27 mg/dL) than the control group (1.97± 0.25 mg/dL) which also found statistically significant (t = 4.30 , p<0.001) (Table 1). These results indicate inverse relationship of serum magnesium and myocardial infarction and is in agreement with previous studies [1,2]. Low serum magnesium level (<1.7 mg/dL) was found in 16 (64%) MI cases while only 5 (20%) patients of the control group had low magnesium levels (Table 2). The difference was statistically significant ($\chi 2$ = 9.52, p<0.01). Similar patterns of epidemology as reported by others, showing increased cardiovascular risk in the presence of low magnesium levels, were observed [4,5,10]. Odds ratio is 7.11 with 95% CI ranging from 2.0 to 25.2, which shows that the subjects with hypomagnesemia has around sevenfolds higher risk of suffering from myocardial infarction compared to those with normal serum magnesium level. This is consistent with previous metaanalysis showing inverse relationship of magnesium and cardiovascular event [2,10]. When distribution of magnesium is analysed, most of the myocardial infarction cases are observed to have value in the range of 1.3 to 1.6 mg/dL while the normal (1.7 to 2.2 mg/dL) range dominates in the control group. Such distribution lends credibility to the argument of magnesium deficiency being involved in myocardial injury via various mechanisms like coronary vasospasm, thrombogenicity and arrhythmogenesis [7,8,9]. Overall, the statistics indicate decreased serum magnesium levels and higher prevalence of hypomagnesemia in patients of

myocardial infarction and support the previous litereature which suggests role of magnesium in atheroscelerotic cardiovascular disease.

Table 1 Mean Serum Magnesium levels

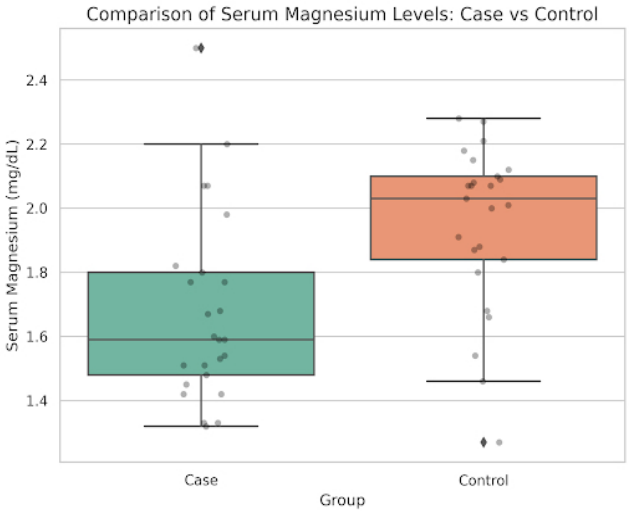
Variable	MI Cases (Mean± SD)	Controls (Mean± SD)	t value	p value
Magnesium (mg/dL)	1.66 ± 0.27	1.97 ± 0.25	4.30	<0.001

Table 2 Distribution of Hypomagnesemia

Magnesium Status	MI Cases (n=25)	Controls (n=25)	Total
<1.7 mg/dL	16	5	21
≥ 1.7 mg/dL	9	20	29
Total	25	25	50

- **Chi Square -** 9.52 (p value < 0.001)
- **Odds Ratio** - 7.11
- **95% Confidence Interval** - 2.0 - 25.2

Fig 1



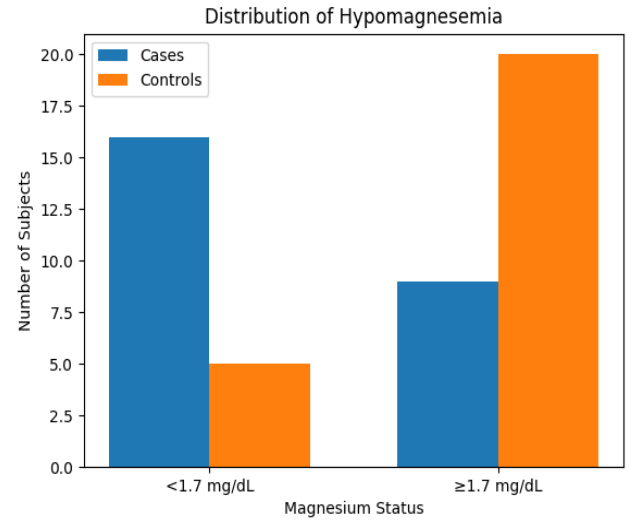


Fig 1- comparison of serum Magnesium Levels in Study Population

Fig 2 - Distribution of Hypomagnesemia in study Population

DISCUSSION

This case control study demonstrates a statistically significant link between low serum magnesium concentrations and myocardial infarction. Our results reveal that the average serum magnesium level in cases was 1.50 ± 0.25 mg/dL , a figure signifcantly lower than the 1.90±0.30 mg/dL found in control group ($p<0.001$). A striking 64% of patients with myocardial infarction suffered from hypomagnesemia, versus just 20% in the controls, highlighting a much higher prevalence of this deficiency in the acute coronary event group. Based on the circulated odds ratio of 7.11, patients with low serum magnesium had approximately a seven time higher likelihood of having a myocardial infarction than those with normal magnesium levels. These data support the contention that hypomagnesemia has a robust relationship with acute coronary events and concur with past epidemological research demonstrating an inverse connection between serum magnesium and cardiovascular risk [2,5,10]. From a pathophysiological point of view, magnesium is key in maintaining cardiovascular homeostasis. It acts as an endogeneous calcium antagonist to regulate the tone of smooth vascular muscles and to avoid over vasoconstriction. Low magnesium facilitates intracellular calcium buildup causing coronary vasospasm, increased peripheral vascular resistance and diminished myocardial oxygen delivery. Moreover, hypomagnesemia facilitates platelet aggregation and thrombus formation that adds to coronary artery obstruction [1,7,9]. Magnesium plays an electrophysiological role in stabilizing myocardial cell membrane and in the regulation of ion channels. Magnesium deprivation increases the likelihood of arrhythmia which are frequent in patients with acute myocardial infarction. Further, it is involved in several adenosine triphosphate dependent enzymatic reactions and magnesium depletion hinders myocardial metabolic function intensifying ischemic damage [8,9]. The outcome of this study is in accord with past research. Almoznino Sarafan et al reports a significant reduction in magnesium levels in patients with acute myocardial infarction and considers hypomagnesemia as an independent cardiovascular risk factor. Likewise, Shecter discuss the cardioprotective action of magnesium that protects against endothelial dysfunction and thrombosis [1].Rasmussen et al also discribes a correlation between magnesium insufficiency and ischemic heart disease [7]. Nevertheless, there are certain limitations to this study. The study's sample size (n = 50) is limited and findings might not be generalizable. Serum magnesium represents only a small component of total body magnesium and might not reflect the intracellular reserves [8]. Also, possible confounders such as diet,habits and drugs used concurrently were not completely adjusted. However despite its limitations the current study presents clinical data which supports the part played by magnesium in cardiovasucular risk stratification. Given the strong relationship found, it is suggested that serum magnesium could be measured as an adjunct biomarker among patients susceptible to developing myocardial infarction which is in tune with other litereature on its significance for cardiovascular prevention and control [2,5].

CONCLUSION

The case control study has demonstrated an inverse relationship between serum Magnesium and Myocardial Infarction.There was higher prevalance of hypomagnesemia in Myocardial Infarction cases and this is in agreement with other studies that report an inverse relationship between magnesium levels and Myocardial Infarction cases and that is in agreement with other studies that report an inverse relationship between Magnesium levels and risk of cardiovascular diseases [2,5,10]. These data suggest that low serum Magnesium levels may play an important and potentially modifiable role in pathogenesis of acute coronary syndromes. Magnesium has also shown to have cardioprotective effects by its action. Thus, it may be suggested that serum magnesium could be an adjunctive indicator in identifying people at higher risk of myocardial infarction.

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