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Elevated Troponin I and Low Serum Magnesium Levels are Suggestive of Greater Cardiac Damage in Acute Myocardial Infarction

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Abstract

Background: Myocardial infarction (MI) is a common and widespread disease in the present world. Magnesium has been considered an important factor in the pathogenesis of acute myocardial infarction and its complications. Also, in response to myocardial injury cardiac Troponin I (cTnI) is released into the blood. This biomarker is widely used for determining myocardial infarction since its serum value is frankly proportional to the area of infarction. The association between serum magnesium levels and Troponin I denotes a negative correlation suggesting major adverse outcomes in patients of Acute Myocardial Infarction. **Objective:** This study aimed to illuminate the association between magnesium levels and area of infarction. Thus, we compared serum levels of magnesium and Troponin I in Acute Myocardial Infarction patients. **Methods:** This cross-sectional descriptive study was conducted in the Department of Pharmacology & Therapeutics, Rajshahi Medical College (RMC), Rajshahi, in collaboration with the Cardiology Department of RMC between July 2019 to June 2020. Assessment and comparison of Troponin I and serum magnesium levels in 50 patients of acute MI was done in this study. **Results:** The mean Troponin I level of respondents with complications was 7.44±6.92 and in patients without complications it was 2.17±2.09. Troponin I level was higher in patients with complications than those who had no complications. On comparison which was statistically significant. (p-value<0.001) **Conclusion:** Measurement of Troponin I and serum magnesium levels have prognostic significance for early detection and management of major adverse outcomes in patients of acute myocardial infarction.

Keywords: Acute myocardial infarction, Troponin I level, Serum magnesium level.

Introduction

Myocardial infarction (MI) is a frequent and widespread disease. The middle-income world is facing this situation more where males are more commonly affected than females. In recent years, studies of magnesium and its effects on various body systems have been getting the most concern. More than 300 enzyme systems in our body are run by this fourth abundant micronutrient as a cofactor.[1] Almost 35% of total magnesium is located in high metabolic tissues such as muscles, brain, heart, kidneys and liver. The serum Magnesium represents only 1% of the total body magnesium.[2]

As a cardio-protective component, magnesium is well-recognized because of its β-adrenoceptor blocking action. Its beneficial effects include reducing vulnerability to oxygen-derived free radicals and improving endothelial function. In addition, it inhibits platelet aggregation and adhesion. It is well known for maintaining normal functional integrity and myocardial electrical stability.[3] Magnesium is beneficial for its ion stabilizing effect which helps in maintaining stable intra and extracellular concentrations of other electrolytes. A low level of serum magnesium is associated with atherosclerotic acceleration, inducing hyperlipidemia and subsequent atherogenic deposits in coronary arteries which is well established.[3] Mg deficiency contributes to continual low-grade inflammation

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proceeding to cardiovascular diseases. Its role in the pathogenesis of coronary spasms, acute myocardial infarction, and ventricular arrhythmias has been reviewed and proven. There is evidence that magnesium depletion may instigate coronary spasms in retrospective human studies. It is identified that an infarcted myocardium loses magnesium and this may be the origin for ventricular arrhythmias.[1]

Magnesium deficiency is associated with a decline in intracellular potassium and an increase in sodium and calcium concentrations. Moreover, oxidative injuries can even be potentiated due to Mg deficiency in the post-ischemic myocardium indicating more extensive myocardial damage, which forecasts poor cardiovascular conclusions.[3] In response to myocardial injury cardiac Troponin I (cTnI) is released into the blood. This biomarker is widely used for determining myocardial infarction since its serum value is frankly proportional to the area of infarction.[4] Troponin I measurement plays an important role because it is specific to the myocardial tissue, has a high sensitivity and can detect the presence of small-size myocardial necrosis that is not detected on electrocardiogram examination or by CK-MB.[5] In the course of acute myocardial infarction the degree of myocardial damage is directly linked to prognosis. So, early determination of infarct size following acute myocardial infarction is thus the key to assessing the future risk of patients and optimizing therapeutic strategies.[6] For illuminate the association between area of infarction and magnesium levels, we compared serum levels of Troponin I and magnesium in patients admitted with Acute Myocardial Infarction. A significant negative correlation between lower Mg levels and elevated Troponin I levels was demonstrated in this study.

Materials and methods

This study was a cross-sectional descriptive type design. It was conducted in the Department of Pharmacology and Therapeutics in collaboration with the Cardiology Department of Rajshahi Medical College Hospital. The study was carried out over one year period from July 2019 to June 2020. Before the beginning of the study, ethical clearance was obtained from the Ethical Review Committee of Rajshahi Medical College. Fifty (50) clinically diagnosed acute myocardial infarction patients admitted to the Cardiology Department of Rajshahi Medical College Hospital, Rajshahi, were included in this study. A convenient and purposive sampling technique was applied to take the study population. For sampling the inclusion criteria were:

- Acute MI Patients presenting within 24 hours of onset of MI confirmed by clinical features and elevated Troponin I level.
- The age group of 35-65 years.

According to the following criteria, respondents were excluded from the study:

- Chronic diarrhoea
- Long-term vomiting
- On magnesium compound or antacids
- Chronic renal disease
- Carcinoma

After filling all inclusion and exclusion criteria and confirming the diagnosis by clinical features, cardiac enzyme Troponin I and electrocardiography; other relevant laboratory investigations were done. With appropriate consent and required permission, 3 ml venous blood was taken from each subject in a test tube without anticoagulant. The blood was then centrifuged for 15 minutes at 3000 rpm and serum was separated and collected. Serum magnesium was measured first on admission day. Measurement of serum magnesium level was carried out by spectrophotometer using Magnesium Kit. All significant information was collected and compiled. Gathered data were processed and analyzed using SPSS (Statistical Package for Social Sciences), version 22.0. The test statistics applied to analyze the data were descriptive statistics, unpaired t-test, and Chi-square test. The level of significance was set at 5% and P-value < 0.05 was considered.

Results

The study was projected to measure the serum magnesium level and its association with Troponin I among 50 study subjects of acute MI patients. The mean age of the respondents was 54±10.3 years. The highest number of respondents were in the age groups of 51-60 and 60-65 years which occupied 32% each of the total study population. Male respondents were predominant in number occupying 84%. Table 01 shows the demographic characteristics and age distribution of the patients.

Table 01: Demographic characteristics of the respondents

Age (in years)	Patients (N=50)	
	Frequency	Percentage
35-40	6	12%
41-50	12	24%
51-60	16	32%
60- 65	16	32%
Sex		
Male	42	84%
Female	8	16%

Large numbers of the respondents 33 (66%) were hypertensive. The study showed 15 (30%) of respondents had a history of ischemic heart disease (IHD). In terms of family history of ischemic heart disease; we found 31 (62%) had a positive history of ischemic heart disease in the respondents. We also observed that 42% of respondents suffered from concomitant disease.

Table 02: Distribution of the study subjects regarding Hypertension, History of IHD, Family history of IHD and Concomitant disease

Hypertension	Patients (N=50)	
	Frequency	Percentage
Hypertensive	33	66%
Normotensive	17	34%
History of IHD		
Present	15	30%
Absent	35	70%
Family history of IHD		
Present	31	62%
Absent	19	38%
Concomitant disease		
Present	21	42%
Absent	29	58%

Table 03 shows the mean troponin I level of the respondents with complications was higher than that of respondents without complications (7.44±6.92 vs 2.17±2.09); on comparison, it was statistically significant (P<0.05).

Table 03: Mean Troponin I level in respondents

Troponin I (ng/dl)	(N=50)			
	n	Mean±SD	*t-value	P-Value
Without complication	9	2.17±2.09	2.242	0.001
With complications	41	7.44±6.92		0.001

*The unpaired t-test was done to measure the level of significance. P<0.05 was considered significant.

Table 04 shows the serum magnesium level of the study group. We observed higher serum magnesium levels in uncomplicated patients in comparison to patients who suffered from multiple complications (2.25±0.15 vs 1.79±0.37); on the comparison, a statistically significant (P value <0.01) difference was found.

Table 04: Mean serum Magnesium level of complicated and uncomplicated patients

Serum magnesium level (mg/dl)	(N=50)			
	n	Mean±SD	*t- value	P-value
Without complications	9	2.25±0.15	- 3.537	0.001
With Complications	41	1.79±0.37		0.001

*The unpaired t-test was done to measure the level of significance. P<0.05 was considered significant.

In Table 05 distribution of acute MI-related complications in the study group has been shown.

Table 05: Complications developed after Acute Myocardial Infarction

Traits	Frequency	Percentage
No complications	06	12%
Chest pain	34	17%
Tachycardia	24	12%
Bradycardia	16	08%
Heart block	09	4.5%
Heart failure	05	2.5%

Discussion

In this study, the age of the patients was ranging between 35-65 years. This study showed the highest number of respondents in the age group 51-60 years and age group 61-65 years which occupied 16 (32%) of the population respectively. These results are similar to the findings of Anjum et al. where 43.3% of patients were in the age group 51-60 years.[7] The sex distribution of the study group showed male predominance. There were 42 (84%) male patients and 8 (16%) females. Lal and Murmu conducted a study where they observed similar findings showing 29 male and 11 female patients.[8] Subramanyam and Vakrani, subjected the serum magnesium level in 53 patients of acute myocardial infarction where they showed hypertension as a high-risk factor in their study.[10] Likewise this study also demonstrated that hypertension was present in 33 (66%) of the patients.

In this study, a positive history of ischemic heart disease was found in 15 (30%) respondents and

35 (70 %) respondents had no history of ischemic heart disease. In this study, the presence of a family history of ischemic heart disease was found as a risk factor in 31 (62%) patients. In the case of concomitant disease, this study revealed that 21 (42%) patients were suffering from other concomitant diseases. Patients had a history of diabetes mellitus mostly as a concomitant disease. A similar finding was found in a study conducted by Angeline et al. where they stated that diabetes patients are more at risk of developing myocardial infarction.[11] Family history of ischemic heart disease was present in 31 (62%) patients. This resembles the finding of Akila et al. who also found 10 (20%) patients having a positive family history of ischemic heart disease.[9]

In our present study, the mean Troponin I level of the patients without any complications was 2.17±2.09 ng /dl. Besides, the mean level of Troponin I in patients with multiple complications was 7.44±6.92. This reflects that the Troponin I level was higher in those patients who had several complications. Troponin level was highest in patients who developed heart failure followed by the group that had chest pain. A similar finding was found in a study by Nikky Bardia et al.[3] They demonstrated a significant correlation between lower magnesium levels and troponin level elevation. In that study, they showed in patients with Acute Coronary Syndrome (ACS), Mg level was <1.8 mg/dl and they had significantly higher troponin levels of 32.1 ng/ml. Whereas Troponin I level was 25.9 ng/ml when Mg level was ≥1.8 mg/dl (6.2 ng/ml higher; P<0.05). This portends poor cardiovascular outcomes. In their study, they stated that maintaining normal Mg levels in patients at risk may turn into better outcomes if these patients present with an ACS.[3] In another study by Gomathi Damodharan and Anuradha Ganesan a cross-sectional study was conducted in fifty diagnosed patients with acute MI.[12] Serum magnesium and troponin I levels were taken into the study. They concluded that the inverse correlation between serum magnesium and troponin signifies that low serum magnesium levels in patients may have a higher area of infarction.[12]

Zia Sabah et al. also conducted a study aiming to estimate serum magnesium levels and their correlation with cardiac complications and mortality in patients with acute myocardial infarction.[13] Their study comprised 160 patients with acute myocardial infarction where 84 (52.5%) experienced a low level of serum magnesium on admission. Significantly higher proportions of patients with low serum magnesium experienced several complications. They concluded that low serum magnesium levels were associated with poor outcomes in most of the patients admitted with acute myocardial infarction.[13] In an attempt to compare Serum Magnesium and Troponin T in Acute Coronary Syndrome, Ajay Kumar and Shaveta Sagar conducted a study where they included 41 patients diagnosed with Acute Coronary Syndrome.[1] The negative correlation between serum magnesium and Troponin T shown in their study proved low serum magnesium values may have a higher area of infarction.[1] Amitai Segev et al. conducted a study to evaluate the association between serum Mg levels and clinical outcomes in hospitalized non-ST-elevated MI patients.[14] This retrospective analysis was done between the lower serum Mg group (Mg <1.9 mg/dl) and all other patients (Mg ≥1.9 mg/dl). The median serum Mg levels in the low Mg group and normal/high serum Mg group were 1.7 (1.6-1.8) and 2.0 (2.0-2.2) mg/dl respectively. In conclusion, they showed Low serum Mg is independently associated with a higher risk of long-term mortality among patients recovering from an NSTEMI event.[14] In another study, Guipeng An et al. investigated the association of serum magnesium (Mg) levels and major adverse cardiac events.[15] In their study they explained that Mg depletion has a key role in the pathophysiologic features of arrhythmias and coronary artery disease. For patients with myocardial infarction, the risk was 8 to 11-fold higher. In addition, serum magnesium was a significant predictor for MACEs of acute myocardial infarction. In conclusion, they stated low serum level of magnesium may be an important predictor of Major Adverse Cardiac Events for acute myocardial infarction.[15]

Conclusion

Low serum Magnesium is recognized as a significant risk parameter for hypertension, cardiac arrhythmias, and other ischemic heart diseases contributing pathogenesis of acute MI. Also, cardiac Troponin I is a well-recognized biomarker for cardiac damage. It is directly proportional to infarct size which may be highly indicative of poor outcomes in Acute MI patients. So, routine assessment of serum magnesium level is advocated which might be useful for avoidance of major adverse cardiac events. Further study with large populations to assess the correlation between Troponin I and serum Magnesium may be helpful in the prediction of adverse outcomes and opening an enhanced way of management protocol in acute myocardial infarction.

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