Serum Magnesium Levels and Arrhythmias in Acute Myocardial Infarction: A Hospital based Analytical Cross- sectional Study

Rajesh N [1], Velvizhi M [2], RanjithKanna. M [3], Thirunavukarasu MR [4*]

[1,2,3]Assistant Professor, Department of General Medicine, Karur Medical College, Karur, India.
[*4]Associate Professor, Department of Community Medicine, Government Medical College, Pudukkottai, India.

Corresponding Author: Dr. Thirunavukarasu MR.
Email: navuk87@gmail.com

ABSTRACT

Background: Coronary artery disease is the major contributor (54.1%) among deaths due to cardiovascular diseases, globally this number is expected to be around 2.6 million. The myocardium subjected to infarction contains low levels of magnesium. Magnesium deficiency leads to spasm of the coronary vasculature, this has been a major contributing factor to the deaths attributed to Ischemic Heart Disease. **Objective:** To correlate serum magnesium levels with cardiac arrhythmias in acute myocardial infarction. **Material and Methods:** A hospital-based cross sectional study was carried out among 50 patients admitted with acute myocardial infarction at Department of General Medicine, Govt. Rajaji hospital, Madurai. A structured questionnaire was used to collect socio-demographic characteristics of the participants. Additionally continuous echocardiography monitoring and serum magnesium levels were observed and recorded for all the participants. Data was entered and analysed by using Statistical Package for Social Sciences (SPSS) (version 21.0) software package. **Results:** Among the 50 participants, 78% were male and 22% were female. The maximum incidence of acute myocardial infarction was seen in 6th and 7th decades. Six of the patients in the study group died during the stay at hospital. The mean serum magnesium level in 50 patients at the time of admission was 1.79 mg/dl. Among the 29 participants who developed cardiac arrhythmias, the mean serum magnesium level was 1.53 mg/dl whereas mean serum magnesium level in rest of the patients without arrhythmia was 2.18 mg/dl. The mean duration of stay was prolonged in those with hypomagnesaemia. **Conclusions:** Acute myocardial infarction patients with low magnesium level were more prone to develop ventricular arrhythmias as compared to those with normal magnesium levels. Magnesium replacement therapy for acute myocardial infarction patients with low serum magnesium level may reduce the incidence of arrhythmias.
Key words: Myocardial Infarction, Serum Magnesium, Arrhythmias, Hypomagnesaemia

INTRODUCTION

Cardiovascular diseases are amongst the most rapidly emerging cause for mortality in India.[1] There appears to be a significant demographic shift among the incidence of cardiovascular diseases based on the decreasing age of the affected population.[2,3] Coronary artery disease is the major contributor (54.1%) among deaths due to cardiovascular diseases, Globally this number is expected to be around 2.6 million.[4]

Magnesium is one of the essential ions required for ATP synthesis within the myocytes for its role as an activator of many enzymes requiring ATP. Myocardium has a higher content of magnesium as compared to other tissues. Magnesium is one of the crucial ions in maintaining the proper functioning

of eth cardiac tissue. Studies have shown that magnesium level in the blood decreased in the first 48 hours following an acute myocardial infarction and then increased steadily to reach the normal level in about three weeks' time.[5,6]

Studies have shown that myocardium subjected to infarction contain low levels of magnesium. These findings directly correlate with the resultant complications of myocardial infarction, such as arrhythmias.[7, 8] The present study was designed to know the relationship between serum magnesium levels and arrhythmias in those who develop acute myocardial infarction.

MATERIAL AND METHODS

Study Setting
The study included 50 participants, admitted over a period of 12 months in the Cardiac Care Unit of Department of General Medicine, Govt. Rajaji hospital, Madurai.

Study Design
This was a hospital based analytical cross-sectional study performed in a tertiary care teaching hospital.

Inclusion Criteria
Patients with acute myocardial infarction (H/o chest discomfort within 12 hours of onset of symptom and ECG changes).

Exclusion Criteria
Patients with chronic kidney disease, on medication inducing arrhythmia and diuretics and patients with hypokalaemia were excluded from the study.

Data Collection Tool
A structured questionnaire was used to collect socio-demographic characteristics and detailed clinical history of the study participants. A clinical examination was done and investigations like ECG and serum magnesium levels was taken for the patients.

Ethical Issues
Clearance was obtained from Institutional Ethics Committee, Govt. Rajaji Medical College and Hospital. Written informed consent was obtained from the participant. The participants were intimated that refusal to participate in the study will not affect the treatment in any aspect. **Statistical Analysis**

The data was entered and analyzed by using Statistical Package for Social Sciences (SPSS) (version 21.0) software package. Descriptive statistics was used to define the study population. Categorical and ordinal variables were expressed as frequency/percentages. Mean and standard deviation was applied to denote continuous variables. Appropriate test of significance (Chi square test and ANOVA) was applied to the study variables to establish the relation between the study variables. The results were considered to be statistically significant when the p value was less than 0.05.

RESULTS

Demographic Characteristics
The mean age in the study group was 56.98 years. Majority of the myocardial infarction was observed among the 40- 60 old age group, while 42% were aged above 60 years of age. Myocardial infarction was observed more among males as compared to females (3.6:1). (Table 1)

Table 1: Demographic Characteristics of the study participants (n= 50)

Age Distribution		
	Frequency (n= 50)	Percentage (%)

Less than 40 yrs	5	10
40- 60 yrs	24	48
More than 60 yrs	21	42
Gender Distribution		
Male	39	78
Female	11	22

Cardiac Parameters

The cardiac parameters observed in the present study were Duration of chest pain, Type of Myocardial Infarction (based on ECG findings).Types of arrhythmias. Majority of the study participants (68%) were admitted in the hospital before 5 hrs. of experiencing chest discomfort. In The current study, anterior wall infarction (52%) was the most commonly observed type of infarction followed by inferior wall (11%) and posterior wall myocardial infarction (11%). Among the study participants the most commonly observed type of arrhythmias were significant VPCs (30%), Ventricular Tachycardia (14%), II * AV block (10%), I * AV block (6%), RBBB (6%), Ventricular Fibrillation (4%), Sinus Bradycardia (4%) and Complete Heart Block (2%). The outcome of the study showed that 88% of the study participants had recovered. (Table 2).

Table 2: Distribution of cardiac parameters & outcome among the study participants (n= 50)

Duration of chest pain		
	Frequency (n= 50)	**Percentage (%)**
< 2 hrs	17	34
2 – 5 hrs	17	34
> 5 hrs	16	32
Type of MI		
AWMI	16	32
ALMI	10	20
PWMI	9	18
IWMI	9	18
LWMI	6	12
Arrhythmias		
Significant VPC	15	30
VT	7	14
AV Block II*	5	10
AV Block I*	3	6
RBBB	3	6
Sinus Bradycardia	2	4
VF	2	4
Complete Heart block	1	2
Nil	21	42
Outcome of the study		
Died	6	12
Recovered	44	88

Serum Magnesium

In the present study, the mean magnesium concentration at admission was 1.792 mg/dl. Hypomagnesaemia (< 1.7 mg/dl) was seen in more than half of the cases included in this study

(54%). Magnesium levels were normal in 16 cases (32%) and elevated magnesium levels were observed among 14% of the study participants. (Table 3)

Correlation between Serum magnesium & Arrhythmias, Disease outcome & Duration of stay

The mean serum magnesium concentration in cases with arrhythmias was 1.51 mg/dl while the participants without arrhythmias had a mean concentration of 2.18 mg/dl. Arrhythmias were observed among 29 study participants, among them the majority of the participants had hypomagnesaemia, while 13.8% of the arrhythmia cases had normal serum magnesium levels. The difference was found to be statistically significant (p value = 0.034). Among the 6 deaths observed in the study, 4 cases had hypomagnesaemia, normal and elevated serum magnesium levels was observed in one patient each. This observation was not statistically significant (p value = 0.74). The mean duration of stay of the study population was observed to be 5.48 days. The mean duration of stay in the hospital was significantly higher (p value = 0.01) among the patients with decreased serum magnesium levels (7.59 $\pm$ 3.14) as compared to the patients with normal (5.68 $\pm$ 1.49) and elevated serum magnesium levels (5.0 $\pm$ 1.92). (Table 3).

Table 3: Correlation between Serum magnesium with arrhythmias, Death and mean duration of stay

Variables	n (%)	Sr. Magnesium (mg/dl)			p value
		< 1.7	1.7 – 2.4	> 2.4	
No. of cases	50 (100)	27 (54)	16 (32)	7 (14)	-
Occurrence of Arrhythmias	29 (58)	24 (82.7)	4 (13.8)	1(3.5)	**0.03**
Death	6 (12)	4 (8)	1(2)	1(2)	0.74
Mean duration of stay	-	7.59 $\pm$ 3.14	5.68 $\pm$ 1.49	5.0 $\pm$ 1.92	**0.01**

 *p value <0.05 was considered to be statistically significant

DISCUSSION

In the present study, Majority of the study participants were aged between 40- 60 old age group and male. Within 5 hrs. of experiencing chest discomfort 68% of the patients were admitted in the hospital. Anterior wall infarction (52%) was the most commonly observed type of infarction. Hypomagnesaemia was seen in more than half of the study participants at the time of admission. Serum magnesium levels was found to be significantly higher among patients with arrhythmias. The mean duration of stay in the hospital was significantly lower among patients with elevated serum magnesium levels as compared to participants with decreased and normal serum magnesium levels.

The incidence of myocardial infarction based on the findings from the American Heart Association showed an increase among the population aged more than 45 years of age.[9] Studies from the Indian subcontinent have also reported similar findings were majority of the patients, were the incidence of myocardial infarction was higher among those aged above 50 years.[10-13] In the present study, we have also reported similar findings. Predominance of males (3.6:1) was observed among the patients suffering from myocardial infarction in our study, Faisal et al, Siddique et al and Patil et al had also were reported similar findings.

Our results showed that, anterior wall myocardial infarction was the most common type infarction and had incidence of 52%. Studies from Indore (54%) and Maharashtra (51%), also reported that among patients diagnosed with myocardial infarction upon admission, the most common type was anterior wall myocardial infarction. The incidence of arrhythmias among myocardial infarction

patients was reported to be 93%, 78% and 82.5% as reported by Singh et al, Patil et al and Stock et al respectively. In our study arrhythmias were observed only in 58% of the study participants, Yadav P et al had also reported that 60% of the participants in their study developed arrhythmias during their stay in the hospital. These variations among various studies need to be explored further.

Abraham et al[15] showed that Serum magnesium concentration were low in patient who had AMI as compared to patients with non-cardiac chest pain. Rector et al[16] had also reported similar findings, were serum magnesium levels were low in patients suffering from acute myocardial infarction. Our results also showed that more than 50% of the myocardial infarction had presented with hypomagnesaemia.

Nizam et al[17] reported that myocardial infarction patients with low magnesium levels were more prone to develop arrhythmias. Ambali et al[18] have also observed that the incidence of various types of arrhythmias was low among the patients with elevated magnesium levels. Studies by Behera et al[19], Elming et al[20] and Ceremuzinski et al[21] also show an inverse relation between serum magnesium levels and the incidence of cardiac arrhythmias. Our findings are also in line with the findings of previous studies.

 Studies done by Naksuk et al[22] and Ambali et al[18] have shown a significant association between hypomagnesaemia and mortality of the patients, while, Shafiq et al[23] have reported an U shaped relationship between mortality and the serum magnesium levels. Our results showed that 12% of the study population had died as a result of myocardial infarction, though this was numerically higher among the patients with low magnesium levels, the findings were not statistically significant. Further studies are required to establish the precise relationship between serum magnesium levels and mortality among myocardial infarction patients.

Results from our study showed a significant increase in the duration of hospital stay among the myocardial infarction patients with low serum magnesium levels as compared to those with normal and elevated serum magnesium levels. These findings are in concurrence with shafiq et al[23], were they have also reported a significant association between decreased serum magnesium levels and increased duration of stay in the hospital.

CONCLUSION AND RECOMMENDATIONS

Hypomagnesaemia was significantly higher among the myocardial infarction patients. Decreased serum magnesium levels were significantly associated with the incidence of arrhythmias and increased duration of stay in the hospital. The inclusion of magnesium therapy in the early stages of management of myocardial infarction would be an added advantage for better outcomes. The role of dietary magnesium supplements should be undertaken to better understand the role of effect of magnesium in managing myocardial infarction.

Conflict of interest: None declared
Source of funding: None

REFERENCES

1. WHO | Noncommunicable diseases country profiles 2014 [Internet]. WHO. [cited 2017 Feb 22]. Available from: http://www.who.int/nmh/publications/ncd-profiles-2014/en/
2. Cardiovascular disease - Diabetes UK [Internet]. [cited 2017 Feb 22]. Available from: https://www.diabetes.org.uk/Guide-to-diabetes/Complications/Cardiovascular_disease/
3. Huffman MD and Engelgau MM. Economic impact of non-communicable diseases in India. India Health Beat. 2012; Vol 6(2).

4. Ghaffar A, Reddy KS, Singhi M. Burden of noncommunicable diseases in SouthAsia. British Medical Journal.2004; 328:807-10.
5. Kharb S, Singh V. Magnesium deficiency potentiates free radical production associated with myocardial infarction. J Assoc Physicians India. 2000 May; 48(5):484–85.
6. Solini A, Zamboni P, Passaro A, Fellin R, Ferrannini E. Acute vascular events and electrolytes variations in elderly patients. Horm. Metab. Res. 2006 Mar; 38(3):197–202.
7. Ising H, Günther T, Bertschat F, Ibe K, Stoboy V, Heldman E. Alterations of electrolytes in serum and erythrocytes after myocardial infarction. Magnesium. 1987; 6(4):192–200
8. Tangvoraphonkchai K, Davenport A. Magnesium and Cardiovascular Disease. Adv Chronic Kidney Dis. 2018;25(3): 251-260
9. Heart Disease and Stroke Statistics. American Heart Association. 2008:1-40.
10. Siddique M, Fazal I, Ejaz A, Awan ZI. Frequencies and patterns of arrhythmias in anterior and inferior myocardial infarction. Pakistan Armed Forces Med J. 2009; 59(4). 450-454. Retrieved from https://pafmj.org/index.php/PAFMJ/article/view/1755
11. Deshpande JD, Dixit JV. Risk factors for acute myocardial infarction: a hospital based case control study. health and population: Perspectives and Issues. 2008;31(3):164-9.
12. Faizal P, Acharya LD, Padmakumar R, Boppanna K, Pandey S. Evaluation of risk factors and in-hospital outcomes in patients with coronary artery disease in a tertiary care teaching hospital. Int J Pharm Tech Res. 2009;1(4):1378-86.
13. Patil PR, Khatana P, Patil DR. Incidence of cardiac arrhythmias in patients with acute myocardial infarction during the first 48 hours of the onset of chest pain. Int J Adv Med 2017;4:1144-9.
14. Yadav P, Joseph D, Joshi P, Sakhi P, Jha RK, Gupta J. Clinical profile and risk factors in acute coronary syndrome. National J Comm Med. 2010;1(2):150-1.
15. Abraham AS, Eylath U, Weinstein M, Czaczkes E. Serum magnesium levels in patients with acute myocardial infarction. N Engl J Med 1977;296:862-3.
16. Rector WG, De Wood MA, Williams RV, Sullivan JF. Serum magnesium and copper levels in myocardial infarction. Am J Med Sci 1981;281:25-9.
17. Nizam A, Muhammad A, Yousuf MH. Serum Magnesium in Acute Myocardial Infarction and its Relation with Arrythmias. P J M H S 2019 MAR 13(1):309-311
18. Ambali AP, Bomman JV. Study of serum magnesium levels in elderly with acute myocardial Infarction. J. Evid. Based Med. Healthc. 2018; 5(45), 3154-3159. DOI: 0.18410/jebmh/2018/642
19. Behera GC, Mohan A, Tripathy G, Padhi PK. Study of Correlation of Serum Magnesium Level with Cardiac Arrythmias Following Acute Myocardial Infarction. JAPI Nov 2010
20. Ceremuzyński L, Van Hao N.clinical. Ventricular arrhythmias late after myocardial infarction are related to hypomagnesemia and magnesium loss: preliminary trial of corrective therapy. Cardiology Jun 1993 16(6)
21. Elming HS, Seibaek M, Ottesen MM, Torp-Pedersen C, Holm E, Thode J et al. Serum-ionised magnesium in patients with acute myocardial infarction. Relation to cardiac arrhythmias, left ventricular function and mortality. Magnesium Research Dec 2000 13(4)
22. Naksuk N, Hu T, Krittanawong C, Thongprayoon C, Sharma S, Park JY, et al. Association of Serum Magnesium on Mortality in Patients Admitted to the Intensive Cardiac Care Unit. Am. J. Med.2017:100(2); 229.e5-229.e13.Availablefrom: https://doi.org/10.1016/j.amjmed.2016.08.033.

23. Shafiq A, Goyal A, Jones PG, Sahil S, Hoffman M, Qintar M et al. Serum Magnesium Levels and In-Hospital Mortality in Acute Myocardial Infarction. J Am Coll Cardiol. 2017;Jun 69 (22): 2771–2772