International Journal of Research in Medical Sciences
Mohanani L et al. Int J Res Med Sci. 2019 Nov;7(11):4015-4019
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20194584

Original Research Article

Serum magnesium level and QTc interval prolongation in acute myocardial infarction patients and its correlation with arrhythmias

Laxmi Mohanani, Kuldeep Deopujari*, Raghvendra Singh Meena, T. N. Dubey

Department of Medicine, Gandhi Medical College Bhopal, Madhya Pradesh, India

Received: 28 August 2019
Accepted: 27 September 2019

***Correspondence:**
Dr Kuldeep Deopujari,
Email: drlavimohanani.93@gmail.com

ABSTRACT

Background: Arrhythmias commonly occur early in acute myocardial infarction and remain a common cause of sudden death in AMI. Magnesium has been implicated in the pathogenesis of acute myocardial infarction and its complication like arrhythmia. Magnesium improves myocardial metabolism, inhibits calcium accumulation and myocardial cell death. It improves vascular tone, peripheral vascular resistance, after load and cardiac output and reduces cardiac arrhythmias. The objective of this study to investigate the serum magnesium level and QTc interval prolongation in AMI and its correlation with arrhythmias.
Methods: In this study, 200 patients of AMI were enrolled. ECG and cardiac parameters were examined. Serum magnesium level is measured and the QTc interval was calculated.
Results: MI was more prevalent in the male patients (63.3%) and age group of 41-50 years. Hypertension (35.7%), smoking (34.2%), and diabetes (23.1%) were the major risk factor for MI. Mean serum magnesium level was 1.64±0.37 among those having arrhythmia that is significantly low as compared to those having no arrhythmia among which mean serum magnesium level was 2.28±0.31 ($p<0.001$). Mean QTc was higher (546.88 ms vs. 404.33ms) in patients documented with arrhythmia compared with those who had no arrhythmia ($p<0.001$).
Conclusions: In acute myocardial infarction, patients with low magnesium levels and prolonged QTc interval are more prone to get arrhythmias. So, magnesium treatment can be considered in patients of acute myocardial infarction with low magnesium levels.

Keywords: Acute myocardial infarction, Arrhythmia, Myocardial infarction, Magnesium, Myocardial necrosis

INTRODUCTION

Acute myocardial infarction (AMI) is an event of myocardial necrosis due to an unstable ischemic syndrome. In practice, the disorder is diagnosed and assessed based on clinical evaluation, the electrocardiogram (ECG), biochemical testing, invasive and noninvasive imaging, and pathological evaluation. Acute myocardial infarction is classified based on the presence or absence of ST-segment elevation on the ECG and is further classified into six types.

Infarction due to coronary atherothrombosis (type 1), infarction due to a supply-demand mismatch that is not the result of acute atherothrombosis (type 2), infarction causing sudden death without the opportunity for biomarker or ECG confirmation (type 3), infarction related to a percutaneous coronary intervention (PCI) (type 4a), infarction related to thrombosis of a coronary stent (type 4b), and infarction related to coronary-artery bypass grafting (CABG) (type 5).[1] The usual initiating mechanism for acute myocardial infarction is rupture or erosion of a vulnerable, lipid-laden, atherosclerotic

coronary plaque, resulting in exposure of circulating blood to highly thrombogenic core and matrix materials in the plaque.[2]

When heart rhythm becomes irregular, too fast (tachycardia) or too slow (bradycardia), or the frequency of the atrial and ventricular beats are different, this is called an arrhythmia. Patients may describe an arrhythmia as palpitation or fluttering sensation in the chest. A frequent cause of arrhythmia is coronary artery disease because this condition results in myocardial ischemia or infarction.

When cardiac cells lack oxygen, they become depolarized, which leads to altered impulse formation and/or altered impulse conduction. Arrhythmias can be either benign or more serious depending on the hemodynamic consequence of the arrhythmia and the possibility of evolving into a lethal arrhythmia. Ventricular tachycardia is a serious condition that can lead to heart failure or evolve into ventricular fibrillation and cause death.[3]

In acute MI functional deficit of magnesium occurred due to trapping of magnesium in the adipocytes, as soaps are formed once free fatty acids are released by catecholamines-induced lipolysis. Magnesium has been associated with the pathogenesis of acute MI and its complications. Magnesium ions are essential for the maintenance of functional integrity of myocardium. The serum magnesium concentration found to have great significance in acute MI.[4]

QT interval is defined as the distance from the onset of the QRS complex to the end of the T wave on the electrocardiogram. QT dispersion (QTd) is equal to longer QTc minus shorter QTc measured by 12-lead Electrocardiogram (ECG). QTd reflects inhomogeneity in myocardial and ventricular repolarization. Because of the easy and fast measurement of QTd, it can be used to predict high-risk patients for dysrhythmia after AMI.[5]

QTd is 30 - 60 milliseconds (ms) in healthy patients but increases to 60 - 80 ms in patients with Coronary Artery Disease (CAD). QTc dispersion > 60 ms has independent predictive value for the severity of CAD. In addition, QTd increases after the acute phase of AMI. Increased QTd can cause ventricular arrhythmia, such as torsade de points.[6]

METHODS

It was a prospective and controlled random study, carried out at Gandhi Medical College, Bhopal for 18 months between Sep 2017 to March 2019. Before commencing this study approval from Institutional Ethics Committee and an informed and formal consent was secured from the subjects. In this study, 200 subjects, both male and female were included.

Inclusion criteria

- History of discomfort in the chest.
- Changes in the ECG suggestive of acute myocardial infarction
- Rise of cardiac enzymes.

Exclusion criteria

- Patients having hypokalemia
- Patients on diuretics

MI patients of aged between 20 to 80 years both male and female with symptoms of ischemia, ECG changes indicative ischemia, MI patient with of raised or fallen cardiac biomarkers were included in this study. Patients who don't fulfill the inclusion criteria, pregnant women, non-cardiac patients were excluded from this study.

For all the subject's ECG was taken, cardiac biomarkers were recorded. A detailed history of chest pain, sweating, palpitation, vomiting, dyspnea, etc. along with family history of MI was recorded. All subjects were investigated for the risk factors of MI mainly diabetes, hypertension, smoking, and alcoholism. Enzymes study for CPK-MB was done for all subjects. Method of estimation serum magnesium: colorimetric endpoint test with Xylidyl blue as the reagent was used. Magnesium standard: 2.5 mg/dL.

Principle: Magnesium reacts with xylidyl blue at alkaline pH resulting in the formation of a chelating red-colored compound. The increase in the red color (or) the decrease in blue color is proportionate to the concentration of magnesium in the serum. Specimen: Analysis of non-hemolyzed serum or lithium heparin plasma may be done since the concentration of magnesium inside the red cells is 10 times greater than that in the ECF. Separation of serum from the cell should be done as early as possible and hemolysis should be avoided. Normal range for magnesium Serum magnesium: 1.6-2.4 mg/dl.

All the data were analysed using IBM SPSS ver. 20 software. Cross tabulation and frequency distribution were used to prepare the tables. Quantitative data were expressed as mean and categorical as a percentage. Chi-square test was used to compare categorical data whereas as one way ANOVA and independent-sample t-test was used to compare the means of a variable. Level of significance was assessed at 5%.

RESULTS

MI was more prevalent in the male patients (63.3%) and age group of 41-50 years (26.6%) followed by 51-60 years (22.6%) and 31-40 years (18.6%). Hypertension (35.7%) followed by smoking (34.2%), dyslipidemia (30.7%) and presence diabetes (23.1%) were the most common risk factor for the development of MI.

Table 1: MI Location Distribution.

MI Location	Frequency	Percent
ALWMI	34	16.1
ASWMI	30	4.0
AWMI	57	30.7
ILWMI	16	12.6
IWM I+RVMI	5	0.5
IWMI	50	25.1
IWMI+AWMI	5	2.5
IWMI+PWMI	3	2.5
Total	200	100.0

AWMI: Anterior wall myocardial infarction, IWMI: Inferior wall myocardial infarction, RVMI: Right ventricular myocardial infarction, PWMI: posterior wall myocardial infarction. ALWMI: Antero lateral wall myocardial infarction, ILWMI: Inferolateral wall myocardial infarction, ASWMI: Anteroseptal wall myocardial infarction.

Table 1 and Figure 1 shows incidence of myocardial infarction with respect to site. AWMI (30.7%) followed by IWMI (25.1%) were the most common affected location in MI patients. Figure 1 shows distribution of patients with respect to occurrence of arrhythmia. Among 200 patients of myocardial infarction arrhythmia was documented in 130 patients group A (n=130) and 70 patients had no documentation of arrhythmia group B (n=70).

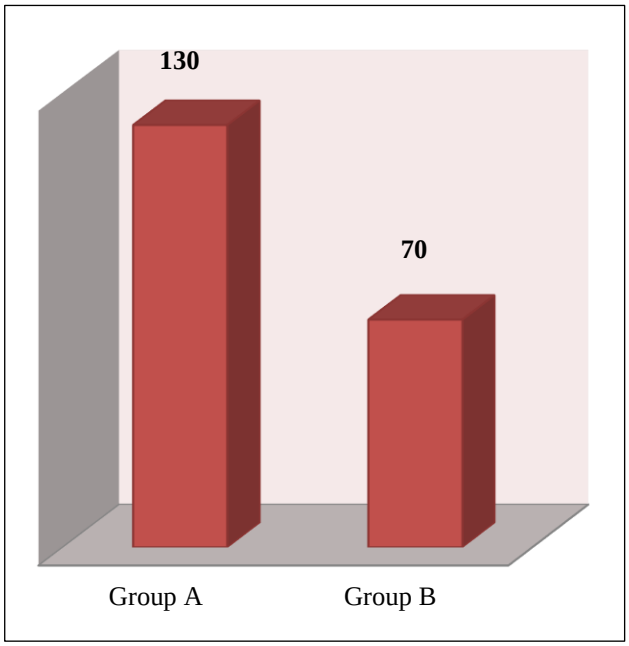

Figure 1: Distribution of patients with respect to occurrence of arrhythmia.

Table 2: Serum magnesium level in both the two groups.

Serum magnesium level in mg/dl	Group A having arrhythmia N=130	Percentage	Group B having no arrhythmia N=70	Percentage
<1.6	54	41%	7	10%
1.6 - 2.40	66	50%	35	50%
>2.40	10	7%	28	40%

Table 2 shows serum magnesium level in two groups. No of the patients in the group A having arrhythmias having serum magnesium level less than 1.6 mg/dl is 54 (41%) compared to group B having no arrhythmia is 7(10%).

No of patients in group A having serum magnesium level >2.40 is only 10 (7%), that is comparatively lower with respect to group B having total no of patients having serum magnesium level greater than 2.4 gm/dl is 28(40%). It is concluded that patients having low serum magnesium are more prone for the development of arrhythmia.

Table 3: Mean serum magnesium level.

	Mean serum magnesium
Mean serum magnesium level in total no of patients n=200	2.28±0.31
Mean serum magnesium level in group A patients having arrhythmia n= 130	1.64±0.37

Table 4: comparing various parameters with arrhythmias status.

		N	Mean	SD	P value
CPKMB	Yes	130	196.07	138.59	0.049
	No	70	153.33	77.14	
	Total	200	186.36	128.34	
Magnesium	Yes	130	1.6402	0.374	<0.001
	No	70	2.2833	0.316	
	Total	200	1.9604	0.440	
QTc	Yes	130	546.88	379.31	0.002
	No	70	404.33	51.76	
	Total	200	513.76	338.43	
LVEF	Yes	130	40.88	10.64	0.487
	No	70	42.09	9.01	
	Total	200	41.16	10.28	

Table 3 shows the mean serum magnesium level in total no of patients and no of patients having arrhythmia. Mean serum magnesium level in total number of patients is

2.28±0.31 while those having arrhythmia is comparatively lower side 1.64±0.37.

Table 4 shows comparision of different parameters with arrhythmia status. Serum magnesium level (1.6402 vs 2.2833) was significantly low among the patients who were having arrhythmia as compared to those who were not having arrhhythmia(p<0.001). Similarly mean QTc was prolonged (546.88 vs 404.33) among those having arrhythmia as compared to those who were having no arrhythmia (p<0.001). while CPKMB and LVEF has found no significant correlation with respect to arrhythmia.

DISCUSSION

Current study records that MI was more prevalent in the male patients (63.3%) and age group of 41-50 years (26.6%) followed by 51-60 years (22.6%) and 31-40 years (18.6%). These results are very much similar to the findings of Mhatre MA et al, in their study maximum incidence of AMI was in 41-70 years of age. There are only 5% cases below the age group of 40 years those too only males. Overall the number of male cases is highly significant (74%) as compared to females (26%).[7]

Similar observations were made by Martin TC et al, MI incidence recorded as 85% between 35 and 75 years of age, the recorded prevalence of AMI was 72% in males and 28% in females which is similar to ours where AMI was 63.3% in male subjects and 33.7% in female subjects. Present study records Hypertension (35.7%) as the major risk factor of AMI which is similar to the results of Mhatre MA et al, study i.e. 23% had hypertension recorded the higher prevalence of AMI.

In current study 34.2% subjects were smokers and experienced the AMI, this is similar to the findings of Teo KK et al, they found that smoking was associated with a greater risk of non-fatal AMI (odds ratio [OR] 2.95, 95% CI 2.77-3.14, p<0.0001) compared with non-smoking; risk increased by 5.6% for every additional cigarette smoked.[8]Current study records alcohol as a risk factor in 30.7% subjects, which is substantiated by the result Sonia SA et al study which recorded 11.2% vs. 29.1% male patients of AMI were alcoholic.[9]

In the current study, diabetes is recorded for 23.1% subjects as a risk factor of AMI which is almost similar to Mhatre MA et al, which also recorded diabetes in 23% cases.[7] The current study found AWMI (30.7%) followed by IWMI (25.1%) were the most commonly affected location in MI patients. Similar observations were made by Mhatre MA et al. where Anterior wall MI was found in 25% and Inferior wall MI in 29%.[7] Similar observation made by another study by Rajhans R et al, who found Anterior wall MI was in 36% and Inferior wall MI in 24%.[10] Magnesium ion has recently been considered as a principle cardiovascular cation. It has many critically significant roles in the maintenance of normal homeostasis of the body. It plays a major role in cardiac homeostasis. Magnesium is an essential ATP activation necessary for the maintenance of the sodium-potassium pump. Magnesium deficiency has been attributed to the causation of arrhythmias in acute myocardial infarction patients.

In the present study of 200 patients, the mean serum magnesium level in all 200 patients was 1.96±0.39. Those patients having arrhythmia mean serum magnesium was found to be 1.64±0.37 that is significantly lower as compared to those having no arrhythmia in that mean serum magnesium was 2.28±0.31 with significant p-value (<0.001). Similar observations were made by Raismusen et al selected 273 patients with a diagnosis of acute myocardial infarction and subjected them to IV administration of magnesium or placebo.

A significant reduction in the occurrence of ventricular arrhythmia in the magnesium group was noticed when compared to the placebo group (p<0.05).[11] Shecter et al subjected 103 patients diagnosed with having acute myocardial infarction to magnesium infusion or placebo for 48 hours. A significant fall in mortality rate (p<0.01) was found. The occurrence of tachyarrhythmias in need of treatment (10/50) has been very low in the magnesium group when compared to the placebo group (24/53).[12]

Morton et al [13] assigned 76 patients to get either magnesium infusion 0.38 mmol/l per kg every 12th hourly or placebo for the first 36 hours of hospital stay. No difference was noticed in the occurrence of ventricular tachycardia among the two study groups. Decker T et al [14] among 905 admissions, found 342 patients with acute myocardial infarction, 563 with other diagnoses. Both acute myocardial infarction and non-AMI group had markedly reduced serum magnesium levels compared to the reference group.

The occurrence of life-threatening ventricular premature beats, ventricular tachycardia or ventricular fibrillation on admission was found to be high in patients with acute myocardial infarction with reduced serum magnesium levels. QT interval prolongs from the opening of QRS complex to the end of T wave. Hence, it comprises the interval of ventricular depolarization (QRS) and repolarization (J point to the end of the T wave). It corresponds to the duration of the cellular action potential. "long-" and "short"-QT intervals are considered as risk markers for cardiac arrhythmias and sudden death.

Present study record that the QTc was prolonged among the patients with arrhythmias (mean=546.88 ms) (p=0.002), similar observations were made by Michels G et al(2016) wherein in a group of 33 arrhythmias patients the mean corrected QT interval (QTc) was 532±29 ms, with 530±31 ms (n = 14) in men and 533±28 ms (n = 19) in women (p = 0.80), respectively. Thus, it is evident that the QT intervals gets prolonged din case of arrhythmias.[15]

CONCLUSION

The current study concludes that MI is more prevalent among the male population than the female population, it impacts the working population significantly. Among risk factors, hypertension smoking, alcohol, and diabetes are the most common. Anterior wall and Inferior wall MI are the most common affected location in MI patients. Patients with low magnesium levels and prolonged QTc interval are more prone to get arrhythmias. So, magnesium treatment can be considered in patients of acute myocardial infarction with low magnesium levels

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD. Third universal definition of myocardial infarction. Circulation. 2012;126(16):2020-35.
2. Libby P. Mechanisms of acute coronary syndromes and their implications for therapy. New England Journal of Medicine. 2013;368(21):2004-13.
3. Richard E. Klabunde, Cardiovascular Physiology Concepts. 2012. Available at: https://www.cvphysiology.com/Arrhythmias/A008. Accessed on 28 Jul 2019
4. Elliot M Antman, Eugene Braunwald: Acute Myocardial infarction in Heart Disease, 6th Ed, Philadelphia Saunders; 2001:1114-1137,1171-1172.
5. Okin PM, Devereux RB, Howard BV, Fabsitz RR, Lee ET, Welty TK. Assessment of QT interval and QT dispersion for prediction of all-cause and cardiovascular mortality in American Indians: The Strong Heart Study. Circulation. 2000;101(1):61-6.
6. Sharafat NI, Khalequzzaman M, Akhtaruzzaman M, Choudhury AK, Hasem S, Choudhury TA, et al. Prolonged QTc dispersion correlates with coronary artery disease in acute ST elevated myocardial infarction (STEMI). Cardiovascular J. 2013;5(2):173-81.
7. Mhatre MA, Sirur FM, Rajpal DR, Shah MR. A clinical study of arrhythmias associated with acute myocardial infarction and thrombolysis. Int J Res Med Sci. 2017;5(1):335.
8. Teo KK, Ounpuu S, Hawken S, Pandey MR, Valentin V, Hunt D, et al. Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: a case-control study. Lancet. 2006;368(9536):647-58.
9. Anand SS, Islam S, Rosengren A, Franzosi MG, Steyn K, Yusufali AH, et al. Risk factors for myocardial infarction in women and men: insights from the INTERHEART study. European Heart J. 2008;29(7):932-40.
10. Rajhans R, Narayanan M. Assessment of arrhythmias in 50 patients of ST-elevation myocardial infarction after thrombolysis: a 24 hour Holter study. Int J Adv Med. 2017;4(3):734-40.
11. Rasmussen HS, Norregard P, Lindeneg O, McNair P, Backer V, Balslev S. Intravenous magnesium in acute myocardial infarction. Lancet. 1986;327(8475):234-6.
12. Shechter M, Hod H, Marks N, Behar S, Kaplinsky E, Rabinowitz B. Beneficial effect of magnesium sulfate in acute myocardial infarction. Am J Cardiol. 1990;66(3):271-4.
13. Morton BC, Nair RC, Smith FM, McKibbon TG, Poznanski WJ. Magnesium therapy in acute myocardial infarction--a double-blind study. Magnesium. 1984;3(4-6):346-52.
14. Dyckner T. Serum magnesium in acute myocardial infarction: relation to arrhythmias. Acta Medica Scandinavica. 1980;207(1-6):59-66.
15. Michels G, Kochanek M, Pfister R. Life-threatening cardiac arrhythmias due to drug-induced QT prolongation. Medizinische Klinik-Intensivmedizin und Notfallmedizin. 2016;111(4):302-9.

Cite this article as: Mohanani L, Deopujari K, Meena RS, Dubey TN. Serum magnesium level and QTc interval prolongation in acute myocardial infarction patients and its correlation with arrhythmias. Int J Res Med Sci 2019;7:4015-9.