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SERUM MAGNESIUM LEVELS IN ACUTE MYOCARDIAL INFARCTION

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ABSTRACT

It has long been known that for normal growth and function inorganic salts must be supplied to all biological forms. In the human body there is a tendency to maintain the proper fluid balance, not only as a whole but between the three compartments of intracellular, interstitial and intravascular spaces. This is maintained by an intricate play of hemodynamic, electrolyte and other forces. The field of mineral metabolism is at present in a phase of rapid expansion. It has become apparent that not only proteins, fats and carbohydrates, but also minerals are essential to life. Now the significance of traces not only of vitamins and other active organic substances, but also of minerals is under intensive investigation. In this cross sectional study, the mean serum Magnesium level on day 1 in all 50 patients was 1.86 meq/L (+/- 0.42) and the mean serum Magnesium level on day 5 was 2.26 meq/L (+/- 0.5) and the mean serum Magnesium level in 26 patients with arrhythmias was 1.738 meq/L on day 1 and 2.145 meq/L on day 5. In this study group, mean serum Magnesium level in 24 patients without arrhythmias was 2.004 meq/L on day 1 and 2.390 meq/L on day 5. The difference between the serum Magnesium levels in patients with and without arrhythmias is statistically significant on day 1. The difference between mean serum magnesium levels in patients who expired was 1.43 meq/L and in patients who survived was 1.92 meq/L. Statistically it was significant.

KEYWORDS: Myocardial infarction, serum Magnesium levels, arrhythmic and non arrhythmic groups, ventricular tachycardia and ventricular fibrillation.

INTRODUCTION

Magnesium has been implicated in the pathogenesis of acute myocardial infarction and its complications like arrhythmias. It plays a significant role in other cardiovascular diseases as well. Magnesium ions are considered essential for the maintenance of the functional integrity of the myocardium.[1]

In 1936, Greenberg and associates described myocardial degeneration with fibrosis and polyplastic infiltration in rats that were fed on low magnesium diet from birth.[1]

Magnesium is the 4th most abundant cation in the body and the second most prevalent intra-cellular cation, next to potassium [2]. Normal body content in the adult is approximately 2000 meq or 24 gms. Magnesium is distributed unevenly, with greatest concentration in tissues having the higher metabolic activity such as brain, heart and kidneys. Approximately 60% of the body Magnesium is in the bone, 1/3rd of the skeletal Magnesium has been shown to be exchangeable and this fraction may serve as reservoir for maintaining a normal extracellular Magnesium concentration.

Extracellular Magnesium accounts for only about 1% of total body content. The normal serum Magnesium concentration is approximately 1.8-2.9 mg/dL.[3] About 70-75% of the plasma Magnesium is ultra-filtrable of which a major portion is ionised. The non filterable portion is bound to plasma proteins chiefly albumin. The remaining of the body Magnesium is intracellular.

The concentration of total Magnesium in cells varies with tissues, but is of order 1-3mmol/L.[4] In general, higher the metabolic activity of the cell, higher the Magnesium content. Low serum Magnesium concentration usually implies Magnesium deficiency. The serum Magnesium however may not represent intracellular Magnesium. Intracellular Magnesium depletion may exist despite normal serum Magnesium concentration.[5] Because tissue and cellular assays are difficult to perform, and not widely available, the serum Magnesium determination is the method by which Magnesium deficiency is identified in clinical practice.

Cardiac muscle has a significant amount of Magnesium (17.4-19.8 meq/L). Higher concentration of Magnesium is found in ventricles than in atria. There are no significant

differences between Magnesium concentrations in the left and right ventricles or inter-ventricular septum.[1]

Magnesium has been shown to be involved in ATP hydrolysis by myofibrils, and binding and release of calcium ions by sacro-tubule reactions, which are essential to the contraction of heart muscle. Magnesium also stimulates oxidative phosphorylation in heart mitochondria, and affect sodium potassium ATPase of heart membranes, and activates adenyl-cyclase and probably phosphorylase-kinase in the heart. Magnesium may have an influence on muscle tone and conducting system, though the myocardium may be less sensitive to Magnesium than nervous tissue.[2]

The kidney is the principle organ involved in the regulation of Magnesium homeostasis. Approximately 8 meq is excreted in the urine each day. During Magnesium deprivation, Magnesium is retained by the kidneys and <1 meq is excreted into the urine per 24 hours period. When dietary Magnesium is plentiful, or is administered parenterally so that filtered load exceed the normal plasma concentration, the excess Magnesium is excreted rapidly.[6]

Investigations revealed that magnesium level in the blood is decreased in the first 48 hours following a acute myocardial infarction and then increased steadily to reach the normal level in about three weeks time. The heart muscle subjected to myocardial infarction was found to contain a low magnesium concentration. These findings directly correlated with the resultant complications of myocardial infarction, such as arrhythmias.

Myocardial magnesium concentration in patients with sudden death due to ischemic heart disease was found to be very low.[7] It has been pointed out that magnesium has a vital role in ventricular fibrillation, which causes sudden death in IHD. The coronary vasospasm resulting from magnesium deficiency has been suggested as another important factor in the sudden death of IHD.

Magnesium deficiency was also postulated to have role in the genesis of atheromatous plaques in that it leads to hyperlipidemia. Also myocardial infarction is one of the common causes of death at present where prognosis depends on multiple factor of which many still remain unexplained. This study is designed to know the relationship between serum magnesium levels and arrhythmias in patients with acute myocardial infarction.

MATERIALS AND METHODS

By using simple random method, 50 cases of acute myocardial infarction, admitted over a period of 1 ½ years between March 2009 to August 2010.

Inclusion criteria for patients

Those patients presenting to the hospital within 12 hours of onset of symptoms were selected. Patients were considered to have myocardial infarction, only if they had two of the following criteria.

1. History of chest pain.
2. ECG changes of acute myocardial infarction.
3. Rise of cardiac enzymes.

EXCLUSION CRITERIA

Patients with hypokalemia

Cases selected were subjected to a detailed history and thorough physical examination, routine investigations like Haemoglobin, blood counts, urine examination, blood sugar, blood urea, serum creatinine, serum electrolytes, fasting lipid profiles, cardiac enzymes, arterial blood gas analysis and Echocardiography.

Serum Magnesium levels were estimated on day 1 and day 5.

Method of serum magnesium estimation

Methodology: Arsenazo

Principles of procedure

The method utilizes an arsenzo dye which binds preferentially with magnesium. The absorbance of the arsenazo-magnesium complex is measured at 572 nm and is proportional to the concentration of magnesium present in the sample. Calcium interference is prevented by incorporation of calcium chelating agent.[8]

Specimen

Non-hemolysed serum or lithium heparin plasma may be analysed since the magnesium concentration inside erythrocytes is 10 times greater than that in the ECF, hemolysis should be avoided and serum should be separated from the cell as soon as possible.

Reference range of magnesium: 1.3-2.1 meq/L

RESULTS AND DISCUSSION

Table No. 1: Age and sex distribution of the study group.

Age (Years)	Sex		Total
	F (Female)	M (Male)	
20 – 30	0	1	1
30 – 40	0	6	6
40 – 50	0	11	11
50 – 60	1	9	10
60 – 70	6	8	14
70 – 80	2	3	5
80 – 90	0	1	1
90 – 100	2	0	2
Total	**11**	**39**	**50**

In this study group of 50 cases, 39 were males and 11 were females. Male Female ratio was 3.5:1. Maximum incidence of acute myocardial infarction was seen in 4th to 6th decades of life. In males it was more common in 4th and 5th decades and in females it was more common after the 5th decade. Also there were 7 cases of myocardial infarction, who were <40 years of age. Probably the incidence of myocardial infarction is slowly increasing in the young.

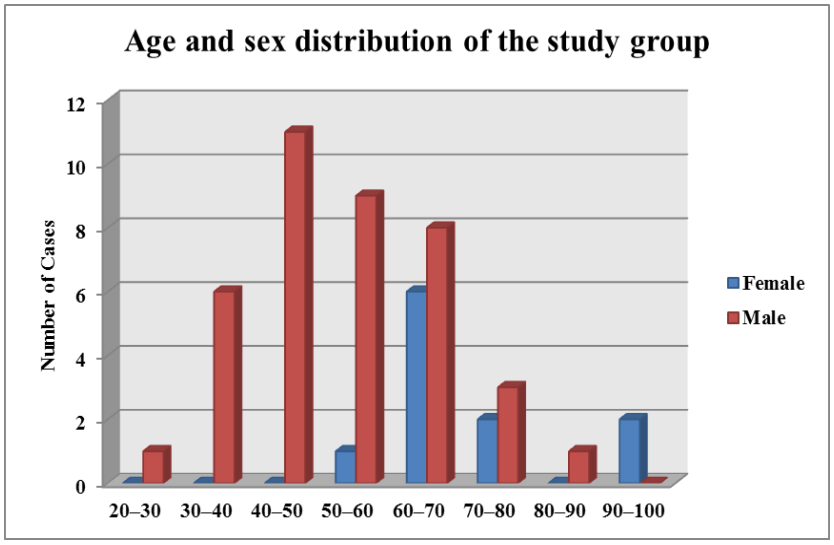

Figure No: 1 Age and sex distribution of the study group.

Table No: 2 Religion wise distribution of cases.

Religion	No. of cases	Percentage
Hindus	34	68%
Christians	11	22%
Muslims	5	10%

In the study of 50 patients, 34 (68%) were Hindus, 11 (22%) were Christians and 5 (10%) were Muslims. The higher incidence of myocardial infarction is not factual one but it reflects the difference in population.

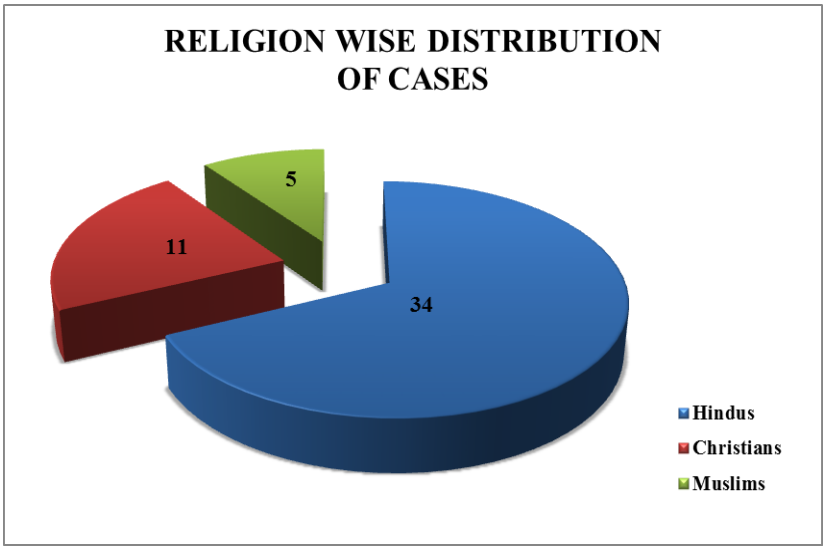

Figure No. 2: Religion wise distribution of cases.

Table No: 3 Time of presentation

Time	No. of cases	Percentage
0 – 5 hours	29	58%
5 – 10 hours	21	42%

Is the present study, chest pain was the commonest symptom, and was present in all cases. 29 (58%) cases presented to the hospital in between 0-5 hours of onset of symptoms and 21 (42%) cases presented between 5-10 hours.

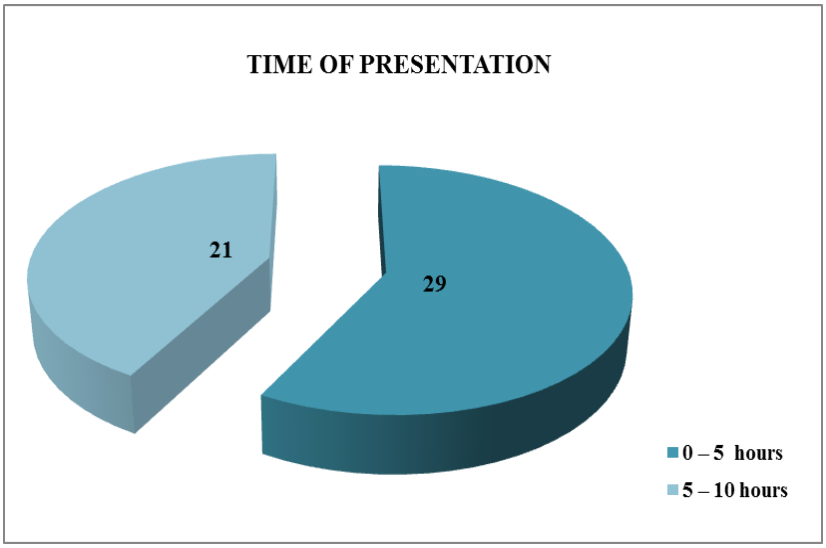

Figure No: 3 Time of presentation

Table No. 4: Incidence of type of myocardial infarction

Type of Myocardial Infarction (MI)	No. of cases	Percentage
Anterior Wall MI	26	52%
Inferior Wall MI	21	42%
Septal MI	3	6%

In this present study, 26 (52%) cases were anterior wall MI, 21 (42%) cases were inferior wall MI and 3 (6%) were septal MI. Right Ventricular MI was seen in 3 patients with association.

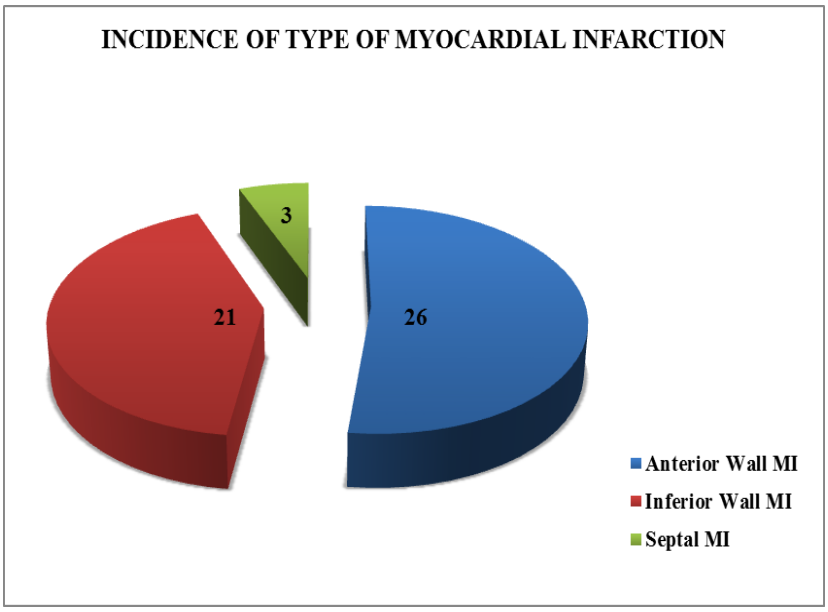

Figure No: 4 Incidence of type of myocardial infarction

Table No: 5 Risk Factors

Risk Factors	No. of Cases
Smoking	24
Diabetes Mellitus	20
Hypertension	19
Hyperlipidemia	9
Previous Ischemic Heart Disease	3
Hyper Homocysteinemia	1
Hypothyroidism	1

In this study, smoking is the most common risk factor found in the patients with acute myocardial infarction (24 cases). Cigarette smoking increases the risk of coronary atherosclerosis in both sexes and all ages and increases the risk of thrombosis, plaque instability and myocardial infarction.

Diabetes and hypertension were also important risk factors seen in 20 and 19 cases respectively.

Other risk factors are hyperlipidemia and previous Ischemic Heart Disease (IHD). In this study, hyper homocysteinemia was found to be a risk factor in 1 patient.

Serum Magnesium Results

In this cross sectional study of 50 patients, the mean serum Magnesium level on day 1 in all 50 patients was 1.86 meq/L (+/- 0.42) and the mean serum Magnesium level on day 5 was 2.26 meq/L (+/- 0.5).

Table No: 6 Serum Magnesium Levels (in meq/L) in patients with Arrhythmias.

	N	Minimum	Maximum	Mean	Std. Deviation
Mg_Day1	50	1.1	2.8	1.866	.4236
Mg_Day5	43	1.5	3.3	2.265	.5056

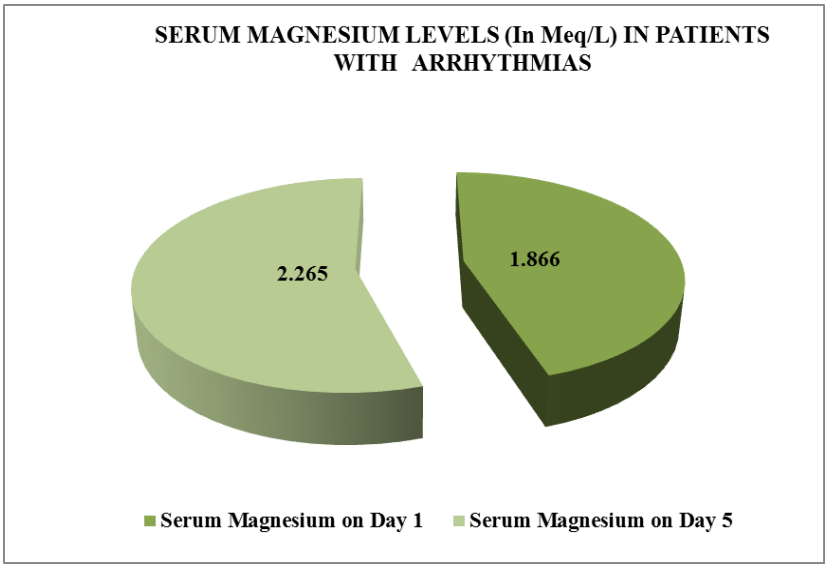

Figure No: 5 Serum Magnesium Levels (in meq/L) in patients with Arrhythmias.

Table No: 7 Serum Magnesium levels in arrhythmic and non arrhythmic groups.

	Outcome	N	Mean	Std. Deviation
Mg_Day1	Arrythmia	26	1.738	.4090
	NonArrythmia	24	2.004	.4027
Mg_Day5	Arrythmia	22	2.145	.5068
	NonArrythmia	21	2.390	.4847

Mean serum Magnesium levels in patients who had arrhythmias was 1.738 meq/L on day 1 and 2.145 meq/L on day 5. Whereas in patients who did not have arrhythmias, the Mean serum Magnesium levels were 2.004 meq/L on day 1 and 2.390 meq/L on day 5.

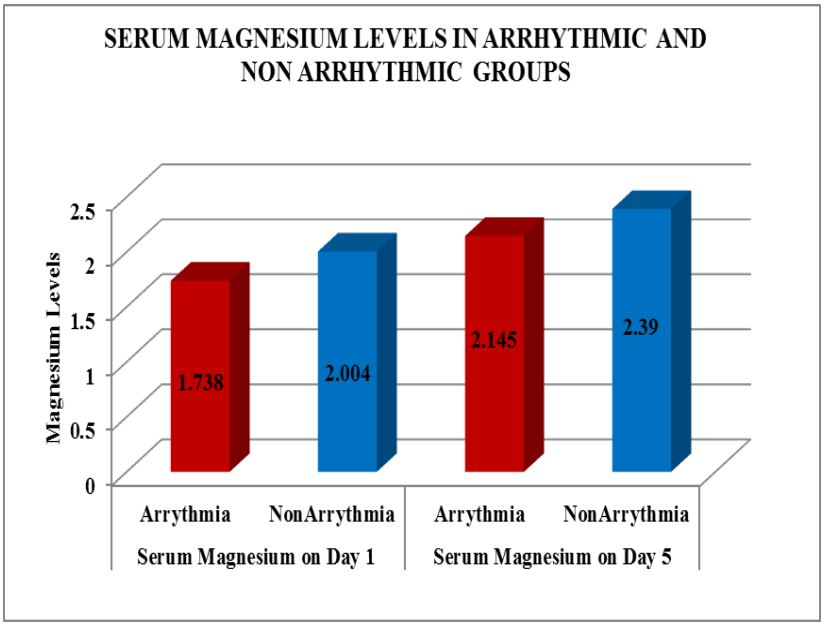

Figure No: 6 Serum Magnesium levels in arrhythmic and non arrhythmic groups.

Table No: 8 Comparison of serum Magnesium levels in patients with arrhythmias and without arrhythmias on day 1.

	No. of cases	Serum Magnesium day 1 (meq/L)	t-value	p-value
Mean Serum Magnesium level in patients with arrhythmias	26	1.738	2.3	<0.05 (0.025)
Mean Serum Magnesium level in patients without arrhythmias	24	2.004		

The above table shows that out of 50 patients, 26 patients had arrhythmias. The Mean value of serum Magnesium on day 1 in those with arrhythmias is 1.738 meq/L (+/- 0.40) and in those without arrhythmias is 2.004 meq/L (+/-0.4). p value is < 0.05. There is significant difference in Magnesium levels in patients with arrhythmias and without arrhythmias.

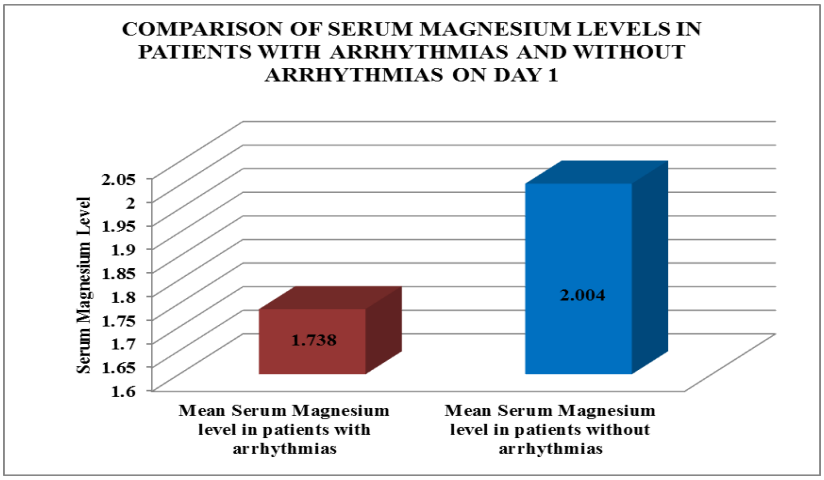

Figure No. 7: Comparison of serum Magnesium levels in patients with arrhythmias and without arrhythmias on day 1.

Table No. 9: Comparison of serum Magnesium levels in patients with arrhythmias and without arrhythmias on day 5.

	No. of cases	Serum Magnesium day 5 (meq/L)	t-value	p-value
Mean Serum Magnesium level in patients with arrhythmias	22	2.145	1.6	0.1
Mean Serum Magnesium level in patients without arrhythmias	21	2.390		

The above table shows that serum Magnesium in patients with arrhythmias on day 5 is 2.145 meq/L (+/-0.5) and those without arrhythmias is 2.39 meq/L (+/-0.4). Statistically there is no significant difference in between the two. Probably because serum Magnesium normalises by 5 days.

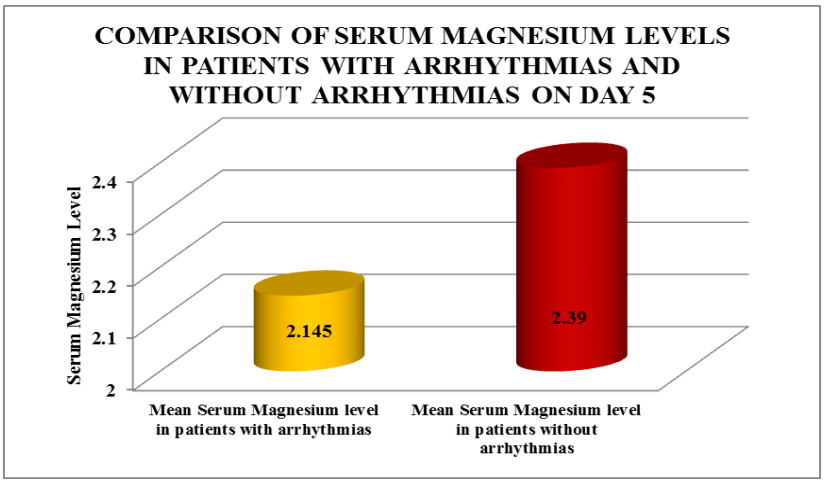

Figure No. 8: Comparison of serum Magnesium levels in patients with arrhythmias and without arrhythmias on day 5.

Mortality

Table No: 10 Comparison of mean serum Magnesium levels in patients who expired and patients who survived on day 1.

	No. of cases	Serum Magnesium day 5 (meq/L)	t-value	p-value
Mean Serum Magnesium level in patients who expired	7	1.43	2.7	<.05
Mean Serum Magnesium level in patients who survived	43	1.92		

In the above study of 50 patients, 7 patients died during 5 days of hospital stay. 4 patients died of Cardiogenic shock, 2 of Ventricular Tachycardia and 1 of Ventricular Fibrillation. Mortality percentage was 14%. Mean serum magnesium levels in patients who survived was 1.92 and who expired was 1.43. There was statistically significant difference in values in these two groups.

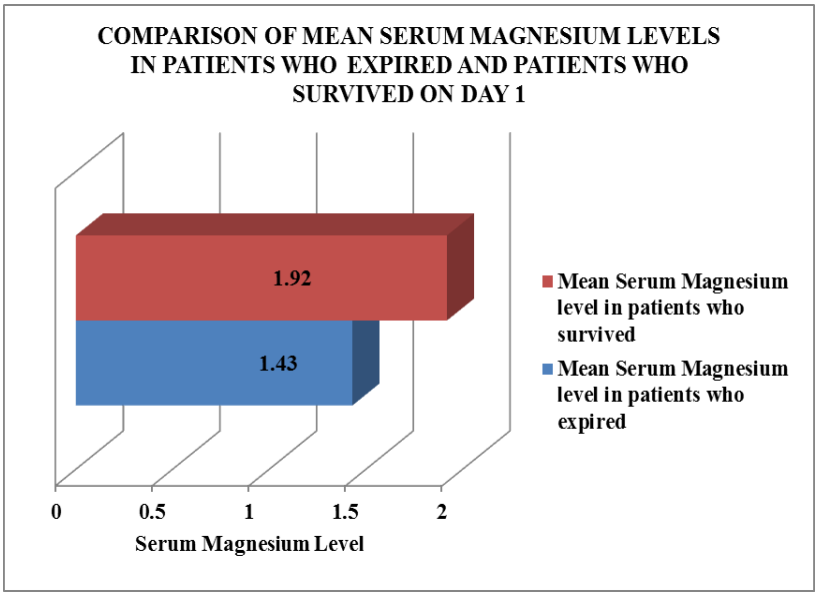

Figure No. 9: Comparison of mean serum Magnesium levels in patients who expired and patients who survived on day 1.

DISCUSSION

Magnesium ion has emerged as a premier cardiovascular cation during the decade. It has been implicated in the pathogenesis of acute myocardial infarction and complication like arrhythmias. Magnesium is essential for activation of ATP, which maintains the sodium-potassium pump and also because of calcium blocking action magnesium has been implicated in relation to arrhythmias after acute myocardial infarction.

In the study group of 50 patients, 39 were males and 11 were females with a male-female ratio of 3.5:1. The maximum incidence of acute myocardial infarction was seen in the 4th and 5th decades.

In the present study of 50 patients, the mean serum magnesium level on day-1 in all 50 patients was 1.86 meq/L (+/- 0.42) and the mean serum magnesium level on day-5 was 2.26 meq/L (+/- 0.5).

In this study, mean value of serum Magnesium on day 1 in those with arrhythmias is 1.738 meq/L (+/- 0.40) and in those without arrhythmias is 2.004 meq/L (+/-0.4). p value is < 0.05. There is significant difference in Magnesium levels in patients with arrhythmias and without arrhythmias.

Abraham et al[9] reviewed magnesium level of 65 consecutive patients with an admission diagnosis of acute myocardial infarction. Serum magnesium concentration were low in patient who had AMI (mean 1.70 mg/dl, p<0.001) or acute coronary insufficiency (mean 1.61 mg/dl, p<0.01), but not in the control group or patients with non-cardiac chest pain (mean 1.91 mg/dl).

Singh A et al[10] checked serum magnesium levels of twenty patients of acute myocardial infarction on the 1st, 7th and 12th day of admission. In all the cases, there was a significant fall of serum magnesium on the first day.

Dimtruk[11] in his series of 67 patients of ischemic heart disease showed a distinct reduction of plasma magnesium during the first 3 days following onset of disease, the level normalized by 15-25 days from onset of the disease.

Sachdev et al[12] (1978) in 30 patients of myocardial infarction determine the magnesium levels within 24 hours, 5th and 8th day and reported as 1.83±0.087 mgm%, 1.91±0.149 and 1.97±0.089 as against control of 2.44±0.162 mgm%. The values were statistically lower on all the three days showing a progressive rise.

In the present study, the serum magnesium level on day-1 was significant lower in patients with arrhythmias than those without arrhythmia (p<0.001). There was an increase in serum magnesium from Day-1 to Day-5 in both those with arrhythmias and those without arrhythmias.

Ceremuzynski et al[13] assigned 48 patients with acute myocardial infarction over 24 hours infusion of magnesium or placebo. The incidence of ventricular tachycardia (3 or more consecutive premature ventricular contraction at a rate faster than 1207 min) recorded by Holier monitoring was significantly reduced ($p<0.001$), but the incidence of other ventricular arrhythmias was not statistically different.

Raismusen et al[14] randomized 273 patients with suspected acute myocardial infarction to intravenous magnesium or placebo. There is a significant decrease in the ventricular arrhythmia in the magnesium group compared to placebo ($p<0.05$).

Shecter et al[15] randomized 103 patients with documented acute myocardial infarction to 48 hours infusion of magnesium or placebo. There is a significant decrease in mortality ($p<0.01$). There was also a non-significant decrease in the number of tachyarrhythmias requiring treatment (10/50) in the magnesium group compared to control (24/53).

Smith et al[16] randomized 400 patients with suspected AMI to a 24 hours infusion of magnesium sulphate or placebo. Two hundred patients had confirmed acute myocardial infarction. The difference in mortality and incidence of ventricular dysarrhtymia requiring treatment between magnesium and placebo groups were not statistically significant.

Abraham et al[17] randomly assigned 94 patients with acute myocardial infarction to receive a daily magnesium bolus of 30 mmol or placebo for 3-days. There was no significant difference in mortality or lethal arrhythmias between patients treated with magnesium and those treated with placebo.

Felstedt et al[18] randomized 298 patients with suspected acute myocardial infarction to 24 hours infusion of magnesium or placebo. Myocardial infarction was documented in 162 patients. During the mean observation period of 245 days, there was no difference in the incidence of tachyarrhythmias, magnesium infusion was associated with a significant increase in bradyarrhythmias.

Singh et al[19] randomized 264 patients with suspected acute myocardial infarction to magnesium, potassium, 10% glucose or 2% glucose infusion. Myocardial infarction was confirmed in 228 patients. Mortality and ventricular tachycardia or fibrillation did not differ significantly between the magnesium group and placebo group.

Morton et al[20] randomized 76 patients to receive either magnesium infusion 0.38 mmol/1 per kg every 12 hour or placebo over the first 36 hours of hospital, there was no difference in the incidence of ventricular tachycardia.

Dyckner T et al[7] during their 1½ years, 905 admission, 342 with acute myocardial infarction, 563 other diagnoses are treated in the CCU on admission both acute myocardial infarction and non AMI group had significantly lower serum magnesium level than as reference group. The incidence of serious ventricular premature beats, ventricular tachycardia and ventricular fibrillation on admission was significantly higher in the hypomagnesemic patients with acute myocardial infarction.

In this present study, serum magnesium level on day-1 significant lower in patients with arrythmias and statistically it was significant. But mean serum magnesium on day 5 was not statistically between arrythmias and non-arrythmias group probably can be explained by normalization of serum magnesium post myocardial infarction.

Mean serum magnesium in patients who had hyperlipidemia was low compared to normal lipid profile group statistically there was no difference found.

CONCLUSION

This study was carried out in 50 patients of myocardial infarction who were admitted in the CCU of Goa Medical College, Goa.

Male to female ratio in the study group was 3.5:1 and maximum incidence of acute myocardial infarction was seen in the 4^{th} and 5^{th} decade.

In the study Hindus were 68%, Christians were 22% and Muslims were 10%.

In this study, the most common presenting symptom was chest pain. All the patients in this study had chest pain. 58% of patients presented within 5 hours of onset of symptoms and 42% presented between 5 to 10 hours of onset of symptoms.

In the study, the most common risk factor was smoking followed by Diabetes and Hypertension.

In this cross sectional study, the mean serum Magnesium level on day 1 in all 50 patients was 1.86 meq/L (+/- 0.42) and the mean serum Magnesium level on day 5 was 2.26 meq/L (+/- 0.5).

In this study group, mean serum Magnesium level in 26 patients with arrhythmias was 1.738 meq/L on day 1 and 2.145 meq/L on day 5.

In this study group, mean serum Magnesium level in 24 patients without arrhythmias was 2.004 meq/L on day 1 and 2.390 meq/L on day 5.

The difference between the serum Magnesium levels in patients with and without arrhythmias is statistically significant on day 1.

The difference between mean serum magnesium levels in patients who expired was 1.43 meq/L and in patients who survive was 1.92 meq/L. Statistically it was significant

Coronary artery disease is a major cause of morbidity and mortality throughout the world. Major cause of death in coronary artery disease are due to complications like arrythmias.

In the present study, patients with acute myocardial infarction with low magnesium level are more prone to develop ventricular arrythmias compared to those who are having normal magnesium levels. Low serum magnesium levels were found in patients who expired compared to patients who survived. Magnesium replacement therapy in patients with acute myocardial infarction who is having low serum magnesium level may reduce the incidence of arrythmias.

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