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RESEARCH ARTICLE

A STUDY ON SERUM MAGNESIUM LEVELS IN ACUTE MYOCARDIAL INFARCTION

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Abstract

Background Of Study: Magnesium has been implicated in the pathogenesis of myocardial infarction and its complication like arrhythmia. Magnesium improves myocardial metabolism and inhibits calcium accumulation and myocardial cell death. It improves vascular tone, peripheral vascular resistance, afterload and cardiac output, reduce cardiac arrhythmias and improves lipid metabolism. Magnesium also reduces vulnerability to oxygen-derived free radicals, improves endothelial function and inhibits platelet aggregation and adhesion.

Objective: To know the relationship between serum magnesium levels and arrhythmias in patients with acute myocardial infarction.

Method: By using a simple random method, 50 cases of acute myocardial infarction were admitted to CHALMEDA ANAND RAO INSTITUTE OF MEDICAL SCIENCES, Karimnagar, Telangana.

Results: There is a significant difference in Magnesium levels in patients with and without arrhythmias.

Conclusion: In acute myocardial infarction, patients with low magnesium levels are more prone to get arrhythmias. So magnesium treatment can be considered in patients with acute myocardial infarction with low magnesium levels.

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Introduction:-

Inorganic constituents form only a small part of the human body, yet they are very essential for sustaining life. It was Liebig (1803-1873) who recognized the importance of minerals as vital parts of plants and animals

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.

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.

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

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sudden death of IHD. Magnesium deficiency was also postulated to have a role in the genesis of atheromatous plaques it leads to hyperlipidemia. Also, myocardial infarction is one of the common causes of death at present where prognosis depends on multiple factors of which many remain unexplained. This study is designed to know the relationship between serum magnesium levels and arrhythmias in patients with acute myocardial infarction ¹

Only 1% of total body magnesium is in the extra-cellular fluid and of this about 25% is in the plasma, the rest is in the red cells. Around 50% of serum magnesium is free, 32% is protein bound and the rest 13% is accounted for magnesium phosphate, citrate and other unidentified complexes. The vascular space constitutes a minor content of magnesium concentration in the body, so the estimation of plasma concentration of Mg does not always impact the actual concentration of Mg in patients, but the intracellular estimation of Mg levels is under research and not popularly available.

The normal human adult body contains 20 – 24 grams of magnesium or approximately 2000 Milli equivalents(meq) of magnesium. Of this only 1% is found in the extracellular fluid.

The normal serum magnesium level is found to be 1.8 – 2.9 mg/dl ². Only 25% of magnesium in the extracellular fluid is found in plasma. Of the total plasma magnesium, about 70% is ultra-filterable. A free form of magnesium constitutes about 50%. Bound form of plasma magnesium is bound to plasma proteins mainly Albumin. Cellular magnesium levels in tissues vary with the metabolic activity of tissues. Higher metabolic activity higher the levels of magnesium. The normal cellular magnesium level is between 1 – 3 mmol/L ³. Intracellular magnesium levels may not always correlate with serum magnesium levels, because only 25% of total extracellular magnesium is found in serum ⁴. But cellular assays of Magnesium are not reliable and not widely available.

So serum magnesium estimation remains the best method to evaluate magnesium deficiency or magnesium excess.

Myocardial magnesium:

Most of the magnesium in the human body is found in bone. The adult human body contains between 20 and 30gms of magnesium. Cardiac muscles also have a significant concentration of magnesium. The higher concentration of magnesium is found in ventricles than in atria. There is no significant change in the amount of magnesium between the right and left ventricles or the interventricular septum ⁵. Magnesium was found to be involved in the ATP hydrolysis of myofibrils, super-precipitation and interests of actinomycin gels, and binding and release of calcium ions by microtubule reactions, which are essential to the contraction of the heart muscle. Magnesium activates adenyl cyclase, stimulates oxidative phosphorylation in heart mitochondria and affects sodium-potassium ATPase of heart membranes. Though the myocardium is less sensitive than nervous tissue to magnesium, it may have an influence on muscle tone and conducting system. ⁶

Magnesium has modest electrophysiologic effects. Intracellular hypokalemia, hyponatremia and an increase in cell excitability may be associated with magnesium deficiency. Magnesium has an effect on real and adjusted SA node conduction time, increases AV conduction time, and has an effect on relative refractory periods, during ventricular pacing QRS duration is extended lengths of the cycle of more than 250 milliseconds ⁷. Zwillinger ⁸ was the first person to discover the effect of Mg on arrhythmias and was later used widely in the management of arrhythmias and usefully employed in patients with difficult VTs, VAs induced by digitalis and in those with episodes of TdP.

Magnesium was found to be useful in a variety of arrhythmias including both tachy and Brady arrhythmias and was employed widely in clinical practice for the same purpose. Recently many studies have proposed Mg as the most useful drug in various life-threatening arrhythmias ⁹.

Magnesium is the natural calcium antagonist. Magnesium reduces calcium influx to the cells during ischemia and prevents damage associated with ischemia to the myocardium. Magnesium also affects systemic and pulmonary vascular impedance and causes a decrease in many hemodynamic parameters.

Magnesium's role in lipid metabolism:

Mg was found to have the unproven role of many of the bio-molecules involved in cholesterol metabolism

Magnesium therapy showed improvement in cholesterol metabolism such as improvement in the ratio of HDL-C and LDL-C plus VLDL- C.

Anti-platelet and anticoagulant role of magnesium:

Magnesium was found to be the most important cation involved in thrombus formation after calcium. Very high concentration of magnesium has effects on regulating various factors involved in the coagulation cascade. Mg has an important role in the pathogenesis of atherothrombosis in MI and has a proven role in the prevention of arrhythmias associated with myocardial infarction. Mg has effects like the inactivation of various factors involved in the aggregation and activation of platelets and thus prevents thrombus formation^{10,11}

Role of magnesium in endothelial function:

Many studies have shown the crucial role of magnesium on endothelial function. Decreased serum Mg has been found to impair NO synthesis. The decreased production of Endothelial nitric oxide leads to decreased vasodilatation and this predisposes to vascular thrombosis and endocardial ischemia.

Methods And Materials:-

50 Cases of Acute Myocardial infarction, admitted to Intensive Coronary Care Unit of CHALMEDA ANAND RAO INSTITUTE OF MEDICAL SCIENCES, Karimnagar, Telangana

Inclusion Criteria For Patients

Patients were diagnosed to have Acute Myocardial infarction, only if they had 2 of the following characteristics:

- 1) Chest Discomfort.
- 2) ECG features of Acute Myocardial Infarction.
- 3) Elevation of Cardiac Enzymes.

Only those patients presenting to the hospital within 12 hours of the onset of symptoms were included in the study.

Exclusion Criteria For Patients:

Patients with hypokalemia.

Selected patients were subjected to detailed history and thorough physical examination and routine investigations like haemoglobin, Total leucocyte count, Urine examination, blood sugar, Blood urea, Serum creatinine, serum electrolytes, fasting lipid profile, cardiac enzymes and Echocardiography was done in all cases.

The serum Magnesium level was done on Day 1 and Day 5.

Specimen:

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

Reference Range For Magnesium:

Serum Magnesium : 1.6 -2.4 mg/dl

Results:-**Age in sex distribution:**

Age Range(yrs)	Male	Female	TOTAL
30-40	7	1	8
40 – 50	8	4	12
50 – 60	9	4	13
60 – 70	12	3	15
70 - 80	2	-	2

In this study of 50 cases, 38 were males and 12 were females with a male-female ratio of 4:1. The maximum incidence of acute myocardial infarction was seen between 6th and 7th decades of life followed by the fifth and sixth decades. 30 % of patients were in the 6th to 7th decades and 25 % of patients were in the fifth and sixth decades.

Diet:

In this study of 50 patients, 25 per cent (12 patients) were vegetarian in diet and 75 per cent (38 patients) of patients consumed a mixed diet. Non – vegetarians have a higher risk for acute myocardial infarction owing to the higher cholesterol content in their diet.

Risk factors:

RISK FACTORS	NO. OF CASES	PERCENTAGE
SMOKING	38	75%
FAMILY HISTORY OF HTN, IHD, DM, CVA	12	25%
OBESITY	10	20%
HYPERTENSION	25	50%
DIABETES MELLITUS	18	35%
DYSLIPIDEMIA	12	25%

Time of presentation

TIME AT PRESENTATION	NO. OF CASES	PERCENTAGE
0 – 3 HOURS	12	25%
3 - 6 HOURS	25	50%

Variation in the type of Myocardial Infarction

In the present study of 50 patients, 25 (40%) patients had anterior wall MI, 20 (34%) patients had inferior wall MI and 15 (25%) patients had anteroseptal MI.

Serum Magnesium levels in patients with arrhythmias:

SERUM MAGNESIUM(mg/dl)	Day - 1	PERCENT	DAY - 5	PERCENT
< 1.6	12	20%	6	10%
1.6 to 2.50	18	30%	24	40%
>2.5	-	-	-	-

Serum Magnesium levels in patients without arrhythmias:

Serum magnesium (mg/dl)	Day 1	PERCENT	DAY 5	PERCENT
<1.6	6	10%	-	-
1.6 – 2.5	18	30%	21	35%
>2.5	6	10%	9	15%

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 complications like arrhythmias. Magnesium is essential for the activation of ATP, which maintains the sodium-potassium pump and also because of calcium blocking action magnesium has been implicated in arrhythmias after acute myocardial infarction.

In the study group of 50 patients, 38 were males and 12 were females with a male-female ratio of 4:1. The maximum incidence of acute myocardial infarction was seen in the 6th and 7th decades. In the present study of 50 patients, the mean serum magnesium level on day 1 in all 50 patients was 1.78 ± 0.32 and the mean serum magnesium level on day 5 was 2.32 ± 0.44 .

In the present study, the serum magnesium level on day 1 was significantly 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 ¹¹ assigned 48 patients with acute myocardial infarction over 24 hours of infusion of magnesium or placebo. The incidence of ventricular tachycardia 3 or more consecutive premature ventricular contractions at a rate faster than 120/ min) recorded by Holter monitoring was significantly reduced ($p<0.001$), but the incidence of other ventricular arrhythmias was not statistically different.

Rasmussen et al ¹³ randomized 273 patients with suspected acute myocardial infarction to intravenous magnesium or placebo. There is a significant decrease in ventricular arrhythmia in the magnesium group compared to the placebo ($p<0.05$).

Shechter et al ¹⁴ 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 the control (24/53).

Abraham et Al ¹⁶ randomly assigned 94 patients with acute myocardial infarction to receive a daily magnesium bolus of 30mmol or placebo for 3- days. There was no significant difference in mortality or lethal arrhythmias between patients treated with magnesium and those treated with a placebo.

Morton et al ¹⁷ randomized 76 patients to receive either a magnesium infusion of 0.38mmol/l per kg every 12 hours or a placebo over the first 36 hours of the hospital, there was no difference in the incidence of ventricular tachycardia.

Conclusion:-

This study was carried out on 50 patients with acute myocardial infarction who are admitted to the ICCU of CHALMEDA ANAND RAO INSTITUTE OF MEDICAL SCIENCES, Karimnagar, Telangana.

1. The male-to-female ratio in the study group was 4:1 and the maximum incidence of acute myocardial infarction was seen in 6th and 7th
2. In the study, the most common presenting symptom was chest pain which is associated with sweat in 25% of patients and
3. breathlessness in 25% of patients and 6) palpitation in 10%.
4. In the study, the most common risk factor found was smoking followed by hypertension and diabetes.
5. In the study group mean serum magnesium level in 60 patients on day 1 is 1.78 ± 0.32 and on Day-5 is 2.32 ± 0.44 .
6. In the study group mean serum magnesium level in 30 patients with arrhythmia is 1.58 ± 0.30 on day 1 and 1.96 ± 0.32 on day 5.
7. In the study group, the mean serum magnesium level in 30 patients without arrhythmia is 2.10 ± 0.50 on day 1 and 2.56 ± 0.48 on day 5

Coronary artery disease is a major cause of morbidity and mortality throughout the world. A major cause of death in coronary artery disease is complications like arrhythmias.

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

Conflict Of Interest:

None.

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