Research Article

Significance of serum zinc and serum magnesium in patients with ischemic heart diseases

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Abstract

Background: Serum zinc levels have been shown to fall after acute tissue injury, including myocardial infarction. Magnesium (Mg) is a cofactor in more than 300 enzyme systems in the human cells and it has a predominant role in the normal myocardial physiology.

Objective: Study was carried out to assess serum levels of zinc and Mg in patient with ischemic heart diseases (IHDs) (acute myocardial infarction [AMI] and angina pectoris).

Materials and Methods: Total 83 patients evaluated include 58 patients with AMI and 25 patients with angina pectoris. Serum zinc and serum Mg were estimated by atomic absorption spectroscopy method.

Result: Serum zinc levels were higher in patients with AMI than in patients with angina on the 1st day ($t = 8.44$, $P < 0.001$) and on the 12th day ($t = 6.42$, $P < 0.001$) but on the 3rd day it was less in patients with AMI than in patients with angina (not significant). Serum Mg levels were significantly higher in patients with AMI than in patients with angina on the 1st day ($t = 6.50$, $P < 0.001$) and on the 12th day ($t = 2.00$, $P < 0.001$) but on the 3rd day they were significantly lower ($t = 12.77$, $P < 0.001$).

Conclusion: These results suggest that serum zinc and serum Mg have a modest association with the risk of IHDs and showing significant change during IHD.

KEY WORDS: Ischemic heart disease (IHD), zinc, magnesium, acute myocardial infarction (AMI), angina pectoris

Introduction

Ischemic heart disease (IHD) is a modern epidemic and considered as a public health problem. This disease is rapidly increasing because of industrialization and agricultural development.[1] The World Health Organization estimated that in 2004, 12.2% of the worldwide deaths were from IHD. In India, the age of incidence was a decade earlier than the other developed countries. The peak age was between 51 and 60 years with a male predominance.[2]

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Zinc is one of the essential trace elements required by man. It is involved in nearly all aspects of cellular metabolism and is essential for cell division and DNA synthesis.[3–5] Serum zinc levels have been observed to fall after an acute tissue injury. Levels of zinc fall by 30% within 1 or 2 days following an acute myocardial infarction (AMI). At the same time, the extent of the fall also correlates with the complications of AMI. Therefore, it may serve as an indicator in assessing the prognosis following AMI.[6–8] The injured heart muscle shows decreased zinc concentration, which may be related to the loss of LDH – Lactate dehydogenase, from infarcted heart tissue.[9]

Magnesium (Mg) is also one of the most common intracellular electrolyte and the fourth most abundant cation found in the body. In an adult human body, approximately 40% of the Mg resides in the muscles and soft tissue, about 1% in the extracellular fluid, and the remainder in the skeleton.[10] Mg is a cofactor in more than 300 enzyme systems in human cells and it has a predominant role in the normal myocardial physiology.

With the myocardial Mg depletion, all mitochondria swell up and if the situation persists there is a disorganization and disruption of mitochondria. Recent investigations indicated that the loss of Mg may be a basic biochemical mechanism in the evolution of myocardial lesions.[11] Mg depletion influences coronary flow, blood clotting, and atherogenesis.[12,13]

In last few decades, estimation of zinc and Mg has gained importance in diagnosis and management of AMI. Mg ions are essential for the maintenance of functional and structural integrity of myocardium.

AMI has become an interesting object of recent epidemiological studies; details on the causes of AMI are needed to predict its future occurrence in those individuals with a high risk from those with a low risk. In this study, we aimed to investigate the changes in serum levels of some metals such as copper, zinc, and Mg in patients with AMI.

Materials and Methods

This study was conducted in MNR Medical College and Hospital, Sangareddy, Medak, Telangana, India. A total of 83 patients were selected for this study, which included 58 members belonging to AMI and 25 members to angina pectoris.

Inclusion Criteria

Patients with signs and symptoms suggestive of AMI supported by ECG – Electrocardiogram, and biochemical cardiac markers (increased CK-MB – creatinekinase- MB (Isoenzyme), AST – aspartate transaminase, and LDH) were included.

Estimation of Serum Zinc by Atomic Absorption Spectroscopy

Serum was separated from blood and collected into trace element washed tubes. After centrifugation, the serum was transferred to clean polypropylene screw-capped bottles with zinc-free pipettes. Specimens were stored in deep freezer for analysis.

Principle

Fivefold diluted serum samples were aspirated into the atomic absorption flame. The zinc concentration was determined by comparing the signal from diluted serum with the signal from aqueous calibrators, which were prepared in a diluted glycerol matrix (5%) to simulate the viscosity of the diluted serum.

Reagents

1. Glycerol diluent: diluted 50 mL of reagent grade glycerol to 1000 mL with deionized water
2. Calibrators: stock calibrator, working calibrator

Estimation of Serum Magnesium by Atomic Absorption Spectroscopy

Serum was separated from the blood of the patient and was collected into trace element washed test tubes, after centrifugation in zinc-free protein tubes, serum was transferred to clean polypropylene screw-capped bottles. Specimens were stored in deep freeze compartment of refrigerator for analysis.

Principle

Fivefold diluted serum samples with deionized water were aspirated directly into atomic absorption spectrophotometer flame without further treatment. Serum Mg concentrations were calculated from a linear calibration curve resulting from the analysis of calibrators made up with the same diluent and amounts of Na and K equivalent to those present in 50-fold diluted serum.

Reagents

Calibrators: four calibrators were prepared in the range of 0.2 mg% to 0.8 mg% by diluting commercially available Mg reference solution calibrators and stored in polypropylene or polyethylene bottles and stable at room temperature.

Result

In AMI patients, the serum zinc level on the third day showed a highly significant decrease when compared with the serum zinc level on the first day (t = 3.82, p < 0.001). On the 12th day, it showed a highly significant increase (t = 7.25, p < 0.001) when compared with the 3rd day. However, the levels of serum zinc on the 12th day and the 1st day were not significant (t = 1.08, p = NS – Not significant) [Tables 1 and 2].

The zinc levels in control were mean ± standard deviation (SD) of 113.75 ± 11.18 μg/dL. In AMI cases, the serum zinc levels on the first day were significantly high (t = 2.91, p <0.01) when compared with the controls. On the third day, the decreased values were significantly (t = 6.84, p < 0.001) lower than those of the controls. On the 12th day, the increased serum zinc values were significantly higher when compared with those of the controls (t = 6.84, p < 0.001) [Table 1].

The serum zinc levels in patients with angina pectoris were lower than those in the controls (t = 1.72, p = NS) though there was a slight but significant difference in the first and third day values than the controls; there was no statistically significant difference in the serum zinc levels during the follow-up period in patients with angina pectoris (1st day versus 3rd day [t = 1.01, p = NS], 3rd day versus 12th day [t = 1.77, p = NS], and 12th day versus 1st day [t = 0.27, p = NS]) [Table 1].

The serum zinc levels were significantly higher in patients with AMI when compared with patients with angina pectoris on the 1st day (t = 8.44, p < 0.0001) and on the 12th day

Table 1: Mean and SD values of serum zinc

Days	Myocardial infarction		Angina pectoris	
	Mean	SD	Mean	SD
1st day	134.66	29.08	101.40	25.22
3rd day	90.30	23.75	95.74	15.70
12th day	141.38	28.96	103.00	14.70

SD, standard deviation.

Table 2: Mean and SD values of serum magnesium

Days	Myocardial infarction		Angina pectoris	
	Mean	SD	Mean	SD
1st day	2.00	0.12	1.87	0.10
3rd day	1.15	0.29	1.84	0.20
12th day	1.99	0.18	1.87	0.33

SD, standard deviation.

($t = 6.42$, $p < 0.001$). The serum zinc values on the third day in the patients with AMI were low when compared with those of the patients with angina pectoris but this difference was not statistically significant ($t = 1.15$, p = NS) [Tables 1 and 2].

In patients with AMI, the serum Mg level showed highly significant decrease ($t = 21.25$, $p < 0.001$) on the third day when compared with first day. On the 12th day, serum Mg was significantly higher ($t = 18.6$, $p < 0.001$) when compared with the 3rd day values. The serum Mg values on the 12th day were lower than those on the 1st day. However, there was no statistically significant difference between these two values ($t = 0.33$, p = NS).

The levels of serum Mg in controls were mean ± SD = 1.70 ± 0.37 μg/dL. In patients with AMI, the serum Mg levels on the first day were not significantly different when compared with the controls ($t = 0.17$, p = NS). On the 3rd day, the fall was highly significant ($t = 6.17$, $p < 0.001$) when compared with the controls and on the 12th day, the rise was significant when compared with the controls ($t = 2.82$, $p < 0.01$) [Table 2].

The Mg values in patients with angina pectoris were lower on the 3rd day and higher on the 1st day and on the 12th day. However, these differences were not statistically significant, 3rd day versus 1st day ($t = 0.77$, p = NS) and 3rd day versus 12th day ($t = 0.39$, p = NS). The serum Mg levels in patients with angina pectoris on the 1st, 3rd, and 12th day showed no significant difference when compared with the controls. Serum Mg values versus control were the following: on the 1st day ($t = 1.47$, p = NS), 3rd day ($t = 1.09$, p = NS); and 12th day ($t = 1.23$, p = NS) [Table 2].

The serum Mg values in the patients with AMI were significantly higher when compared with those in the patients with angina pectoris on the 1st day ($t = 6.50$, $p < 0.001$) and on the 12th day ($t = 2.00$, $p < 0.05$). The serum Mg values on the third day in patients with AMI were significantly lower when compared with those in the patients with angina pectoris ($t = 12.77$, $p < 0.001$) [Table 2].

Discussion

The acute cardiac conditions showed a wide variation in trace element concentration in serum. Many studies showed that plasma zinc falls in myocardial infarction[7,8,14–17] and the lower concentrations of zinc were relatively remarkable 72 hours after the episode. Myocardial necrosis can therefore be distinguished from angina pectoris.

Zinc levels fell in the first few days and did not return to normal levels for 1.5 to 2 weeks, which enabled both acute and recent infarcts to be detected. The serum zinc levels were not being altered by minor tissue damage or by intramuscular injections.[6] Our results showed significant decrease on the 3rd day of infarction, which came to normal by the 12th day. Those were in accordance with the studies by previous authors. In angina pectoris cases, the serum zinc values did not show any significant change during their stay in the hospital.

The precise reason why the zinc levels fell in AMI was still unknown. The serum zinc levels have been shown to fall after the administration of steroids.[18] Jain and Mohan[19] studied both copper and zinc levels in AMI and concluded that serum zinc levels were useful during the first week and copper levels during the second week after the onset of infarction. Studies by Tan et al.[15] and Sucin et al.[21] suggested that copper/zinc ratio was approximately 1 but in AMI it reached 2.5 and returned to normal during convalescence.[20]

The role of Mg in etiopathogenesis of coronary artery disease is still disputed. Many authors have suggested that the depletion of Mg was a significant etiological factor in the development of IHD.[22,23]

In our study, the serum Mg levels significantly decreased in patients with AMI on the third day of admission. The serum Mg levels returned to initial values by the 12th day of admission. The serum Mg levels in patients with angina pectoris did not show any significant change during the follow-up period. Similar low levels were found by other authors.[18,24] However, some authors reported normal levels of serum Mg in AMI.[25–27] Henry and Cantraw[28] found higher levels of serum Mg in 15 cases of angina pectoris. Serum Mg levels were not affected by age and sex.[25]

Conclusion

This study revealed that the values of serum zinc showed significant decrease on the 3rd day of infarction and came to normal by the 12th day. In angina pectoris cases, the serum zinc values did not show any significant change during the course of treatment. Also, the results of this study showed that the serum Mg levels significantly decreased in AMI patients on the 3rd day of admission. The serum Mg levels returned to initial values by the 12th day of admission. The serum Mg levels in patients with angina pectoris did not show any significant change during the follow-up period. Results suggested that the levels of serum zinc and serum Mg showed significant changes in some conditions of acute IHDs.

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