Serum copper, zinc, and magnesium in acute myocardial infarction in Ramadi municipality

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Abstract:

A prospective study carried out to assess serum levels of copper, zinc, and magnesium of 50 consecutive patients after an acute episode of myocardial infarction, their ages range between 33-77years. Patients having hypertension, diabetes mellitus, and renal diseases and those with other major illness were excluded. They were compared with 25 healthy volunteers for age- and sex-matched as a comparison group for metal measurements. Results showed that patients' mean copper and magnesium concentrations were significantly higher ($P<0.001$) than the mean of controls while the patients' mean serum zinc concentration was significantly lower ($P<0.001$) than in controls**.**

Keywords: acute myocardial infarction (AMI), trace metals.

Introduction:

In the past years, a number of researchers have shown that classical and extrinsic factors such as smoking, high cholesterol levels and high blood pressure, have a significant role in the pathogenesis of cardiovascular disease. Moreover, many other factors have been repeatedly demonstrated to influence this disease which is one of the most prevalent in the developed world[1]. Many prospective studies have implicated metal ions and lipids in the genesis of acute myocardial infarction (AMI)[2].

AMI is defined as a part of acute coronary syndrome characterized by a typical clinical syndrome consisting of chest pain, dyspnoea with rise and fall in troponin or creatine kinase – MB to values greater than 99% of a normal reference population[3]. On the other hand, attention is being focused on metals as risk factors for AMI[4]. Moreover, the values of serum copper, magnesium and zinc were changed in AMI patients than controls[5].

Although AMI has been the object of most epidemiological studies, more information on its possible causes are needed to predict its future occurrence, that is among an apparently healthy population we can distinguish those individuals with a high risk from those with a low risk of subsequently developing AMI. Furthermore, additional knowledge is required about various lipid parameters and metal levels in AMI patients as they can be useful as markers for the disease. There is an association between low dietary magnesium and high dietary iron and increased induction of the disease[6].

The aim of the present study is to investigate the changes in serum levels of some metals as copper, zinc, and magnesium in AMI patients.

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Materials and methods:

This prospective study had been conducted between September 2006 and December 2006. The present study included 75 individuals, categorized into two groups. The first group includes 50 patients consecutively admitted to intensive coronary care unit (ICCU), Al-Ramadi General Hospital (RGH), were taken as a study group. Their ages ranged between 33-77 years (51.23±63), 38 were males and 12 were females. Patients were admitted diagnosed as recent AMI. The second group includes 25 healthy individuals as a control group.

Inclusion criteria: Patients with signs and symptoms suggestive of AMI supported by ECG and biochemical cardiac markers (increased CK-MB, AST, and LDH) who presented within 72 hours were included in this study.

Exclusion criteria: Patients having hypertension, diabetes mellitus, and renal diseases and those with other major illness like anemia, liver disease, and infections were excluded from the study. Patients receiving any drugs in the last 6 months were excluded. Women taking oral contraceptives were not included as it is known that these drugs influence values for serum copper and zinc.

Control group: A 25 normal healthy Iraqi volunteers considered as apparently by clinical examination and with no history of any disease were enrolled. Their sex- age-matched as a compared group in trace elements measurements.

Sample collection and analysis: 5ml of blood samples from patients were collected on admission to ICCU and one or two-days intervals thereafter for analysis at 8 a.m. Specimens were collected at a standardized time to minimize any effect of diurnal variation. Sterile, disposable plastic syringes were used. Blood samples were transferred immediately and carefully (to avoid hemolysis) to clean trace element free polypropylene tubes, left to clot (about half an hour) and the serum was separated by centrifugation (Gallenkamp, Germany) at 3000 rpm for 5 minutes. Serum was divided into several polypropylene tubes, stoppered, labelled and stored at -20°C in refrigerator (Ishtar) until analyzed. Samples kept one to two weeks then forwarded to the Medical Research Centre, College of Medicine, Kadhemiyah (MRC in Baghdad). Serum copper, zinc, and magnesium were determined by flame emission atomic absorption (model AA 6200 Shimadzu). Samples were diluted with dionized distilled water.

Blood sugar, urea, creatinin levels were also done to rule out diabetes, renal, and liver pathology. Blood samples were collected from controls under the same limitations.

All observations were tabulated and analysed. Statistical analysis was performed using Student's t-test to find out clinical significance. ‘p’value< 0.05 was taken as significant, SSPS version 10, to examine the relationship between the trace elements we used the simple correlation coefficient (Pearson) .

Results:

Fifty patients of AMI and 25 healthy volunteers were compared in this study. According to table I, the age of patients ranged from 33 - 77 years. Majority of patients were 41 - 60 years (29 patients = 58%). Out of 50 patients in the study group, 38 were males (76 %) and 12 (24%) were females.

Table I: Age distribution of patients with acute myocardial infarction.

Age In year	No. of patients			Percentage %
	Male	Female	Total	
30-40	6	2	8	16
41-50	12	3	15	30
51-60	11	3	14	28
61-70	7	3	10	20
>70	2	1	3	6
Total	38	12	50	100
Percentage%	76	24	100	

Table II illustrates the comparison of serum copper, zinc, and magnesium levels between patients with AMI and healthy control group. This table reveals a significant increase of serum copper and magnesium of AMI where ($P<0.001$) and ($P<0.001$) respectively when compared with the corresponding control values. The mean level of serum zinc was significantly lower in patients with AMI than in control group **(**$p<0.001$).

Table 2. serum copper, zinc, and magnesium levels in both control and AMI groups.

	Copper µg/100ml (Mean±SD)	Zinc µg/100ml (mean±SD)	Magnesium mg/100ml (Mean±SD)
Control group n=25	86.32±9.97	95.00±17.46	2.03±0.21
Patient group n=50	116.72 ±16.04	63.14±10.01	2.26±0.14
p-value	P < 0.001	P < 0.001	P < 0.001

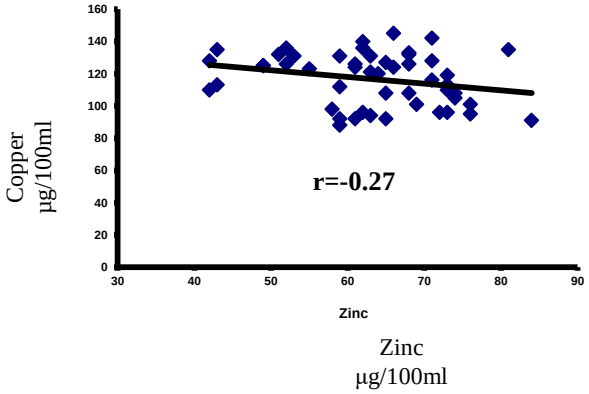

figure 1. correlation of copper and zinc in AMI

According to simple correlation coefficient (Pearson), the correlation between trace metals in AMI patients are not significant as in figure 1.

Discussion:

Some 34 elements have been found epidemiologic relationships with ischemic heart disease[7]. A literature research revealed that the coronary heart diseases have been shown to be a major cause of death in developed counteries[8]. The prevalence of these diseases in developed countries has reached immense proportions which represent a major problem[9]. In recent years, researches concluded that the correlation may be causal because of findings experienced increases in heart disease rats after reducing the hardness of the water supplies[10]. It is now clear that dietary trace elements are associated with heart disease risk. Metals are important constituents of various metalloenzymes which are responsible for the maintenance of myocardial integrity. Imbalanced serum concentrations of metals have been assumed to share in the causes of AMI[11].

In the present study, serum copper level of AMI patients was significantly higher than that of healthy controls ($p<0.001$). Increased patients serum copper levels are a part of a specific defense mechanism to provide more copper at the site of infarction to reduce its size and the extent of damage[12]. Also, the increase of ceruloplasmin, which is a copper containing enzyme and acute phase reactant, may account for the significant increase in serum copper levels[13]. Ceruloplasmin is an acute phase protein and is synthesised by the liver in response to tissue damage and inflammation. Ceruloplasmin is an important intravascular antioxidant and it protects tunica intima against free radical injury. This phenomenon is the basis for constantly observed sudden increase in serum copper and ceruloplasmin levels[14]. Shaded elements are those that may act by either enhancing or inhibiting copper, deficiency of which can produced a wide variety of anatomical, chemical, and physiological pathology in the cardiovascular system[15].

Copper supplements may be beneficial considering that the Western diet often is low in copper and that people with cardiovascular disease have been found to have decreased copper in heart and arteries and decreased activities of enzymes dependent on copper[15-18].

Serum zinc levels of AMI patients were significantly decreased than that of control group ($p<0.001$). Recently, Kodavanti et al[19] reviewed associations between cardiovascular morbidity and mortality and air pollution indices, and have implicated particulate matter containing highly bioavailable zinc[19]. Low serum Zn levels in patient group have been related to excess release of steroids due to the release of leukocyte endogenous mediators which redistributes the body Zn from serum and may cause a drop in serum Zn and also due to elevated levels of α_2-macroglobulin

which is a transport protein containing large amounts of Zn[20]. Recent characterization, suggest that zinc may share absorptive mechanisms with a variety of divalent cations, including cadmium, copper, iron, and lead[21]. Induction of metallothionein by zinc has been shown to alter the physiological disposition of copper[22] and metallothionein has a greater binding capacity for copper than for zinc[23], so causing elevation of serum copper level and lowering serum zinc level.

In the present study, serum magnesium level of AMI patients was significantly higher than that of healthy controls. Myocardial magnesium concentrations have been found to be abnormally low in persons dying from myocardial infarction[24]. The mean myocardial magnesium of those who died from ischemic heart disease (IHD) was 22% lower than the age adjusted mean of those who died accidentally[25]. The elevated serum magnesium may be due to the release of magnesium not only by the infarcted left ventricle but also by the non necrotic left ventricle and the right ventricle. The released magnesium entered the circulation[26].

Tan et al[27] found significantly elevated copper while serum magnesium and zinc slightly lower than in control group in a study carried out on 41 AMI patients and 41 healthy control matched subjects. Metwalli et al[28] showed serum copper and magnesium levels in all patients with AMI were significantly higher than the corresponding values of controls and serum zinc level was not significantly different from that of control group. Issa et al[29] proved that total mean level of serum zinc for patients with atherosclerosis was significantly lower than that of controls and total mean copper was significantly higher in those patients. Lekakis[30] showed that zinc concentration in serum of 99 patients with AMI was significantly low on the second and third days after infarction. Ali et al[31] showed serum zinc concentration in AMI fall sharply within a day of onset.

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