

Ionic imbalance; as risk factor for pathogenesis of cardiovascular diseases

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Key words: Magnesium, lipid, calcium, sodium, potassium

Abstract:

Across – sectional study was conducted on 100 patients (male and female) having cardiovascular dysfunction (Angina, Myocardial infarction, Heart failure) with age ranged from 55-75 years. They were compared with 78 normal healthy person with the same age.

The study was carried out on patients attended to Tikrit Teaching hospital in out door of CCU word in Tikrit city .Fasting blood sample were obtained , serum was extracted and analyzed for serum Ca⁺⁺, Na⁺, K⁺, Mg⁺⁺, serum lipids and lipoproteins were also measured .

Serum Mg⁺⁺ was found to be significantly decreased in the three types of cardiovascular disease for sexes and this correlates inversely with increased serum Na⁺, K⁺ and Ca⁺⁺ levels. Serum cholesterol, Triglyceride and LDL- cholesterol were significantly increased in both sex whereas HDL – cholesterol levels were significantly decreased in male and female for these three type of C.V.D patients.

From this study we obtained that Mg⁺⁺ deficiency affect lipid metabolism and electrolyte levels for the three type of C.V.D in both sexes. Introduction:

Magnesium the second most abundant intracellular cation in mammalian cells after potassium, an essential cofactor for over (300) enzymes involved in many of the normal function of the body. It is important in the synthesis of new tissues and involved in the binding of RNA to ribosome for protein synthesis [1].Total body magnesium approximates (20-28) gm with (65%) found in bone, intracellular Mg (34%) constitutes most of the remaining Mg in the body with the majority of this found in muscle. Only (1%) was found in the extra cellular fluids [2]. The serum magnesium is generally found within three distinct fractions: Ionized Mg (60%), Protein bound (32%), Complexes Mg (6%), within cells (1-2%)

[3, 4] A review of the literature concludes that heart disease patients suffer significantly from magnesium deficiency [5]. Many patients with variant angina have magnesium deficiency, according to the measurements of (24) hours retention rats in patients compared with controls [6]. Other study has been a played in (2001) suggest that hypomagnesaemia may contribute significantly to cardiac morbidity and mortality [7]. In the same year other author suggest that Mg deficiency can potentate oxidative injury to post ischaemic myocardium and that antioxidants may have a role in the protection against the provident influence of Mg

deficiency [8]. The aim of this study is to determine the correlation between ionic imbalance especially (magnesium) and lipid metabolism and variety of CVD and also evaluate the correlation between serum lipid levels and serum magnesium levels in different types of CVD.

Subjects and Methods:The study included a total (100) patient (male and female) having cardiovascular dysfunction's (Angina, Myocardial infarction and heart failure). They were compared with (78) normal healthy persons. Patients with following criteria were selected between age ranging from (55 – 75) years and the duration of cardiovascular disease was (2-3) days There was no other risk factor of cardiovascular disease like diabetes mellitus and hypercholesterolemia. The patients were randomly selected from those coming in out door of CCU word . Blood samples were obtained. Serum was extracted and analyzed for serum Ca⁺⁺, Na⁺, K⁺, Mg⁺⁺, serum lipids and lipoproteins were also measured. Determination of plasma levels of total cholesterol, HDL-C and triglyceride levels was performed by enzymatic and colorimetric methods [9-11]. LDL-C and very low density lipoprotein cholesterol (VLDL-C) levels were calculated from the Friedewald formula [12, 13].

$$VLDL = \frac{\text{Triglycerides}}{5}$$

$$LDL = \text{cholesterol} - (\text{HDL} + \text{VLDL})$$

The estimation of magnesium and calcium were carried out by using colorimetric methods[14,15]. Sodium and potassium are quantities simultaneously by flame atomic emission spectroscopy (FAES). Statistical analysis of the results was applied using mean value, standard deviation, T- test and correlation factor

Results:

The patients divided into three groups:-

Thirty four Patients suffering from myocardial infarction (MI).

Thirty one Patients suffering from heart failure (HF).

Thirty five Patients suffering from unstable Angina.

The above groups were compared with (78) normal healthy individuals as control group .The variation in age,sex and duration of disease in selected patients as well as in control subject are shown in table 1

Table 1 Population characteristic study

Subjects		Age group (year)			Duration (day)
		50-59	60-69	70-79	
Control	Male	18	17	7	-
	Female	12	11	13	
	total	30	28	20	
Myocardial infarction	Male	4	11	5	3
	Female	4	6	4	
	total	8	17	9	
Heart failure	Male	2	11	5	3
	Female	2	8	3	
	Total	4	19	8	
Angina	Male	6	7	3	2
	Female	6	10	3	
	Total	12	17	6	

The mean value and standard deviation for ions (Mg^{++} , Na^+ , Ca^{++} , K^+) and lipid profile in 100 patients divided in to three major categories of cardiovascular disease

(Myocardial infarction MI, Heart failure HF and Angina) and control group are shown in table 2 for male and female, table 3 for male and table 4 for female .

Table 2 Relationship between some ionic levels and other parameters in three groups of cardiovascular disease (Myocardial infarction, heart failure, angina) and control group

Parameters	Control	Patient with		
		MI	HF	Angina
Magnesium(mg/dl)	2.0±0.2	1.4 ± 0.4	1.7 ± 0.35	1.6 ± 0.1
Sodium(mEq/dl)	139±3.1	148 ± 3	147 ± 5.2	148.1 ± 1.4
Calcium(mg dl)	9.2±0.5	10.7 ±0.9	10.3 ±0.9	10.5 ± 0.6
Potassium(mEq/dl)	4.1± 0.25	5.16 ± 0.8	5.2 ± 0.6	5 ± 0.2
T.cholesterol(mg/dl)	193±19	262 ± 42	258.3 ± 29	252 ± 24
Triglycerides(mg/dl)	157± 11	184 ± 31	179 ± 16.2	178 ± 11
LDL(mg/dl)	119±19	189 ± 48	192 ± 42	175 ± 35
HDL(mg/dl)	42±4.9	23 ±4.7	28 ± 2.3	26.8 ± 1.5
VLDL (mg/dl)	31.5±2.1	39 ± 6	35 ± 3.1	35.6 ± 2.1

The correlation between serum magnesium level and serum cholesterol level in patients with three major categories of C.V.D are shown in (Figures

1,2,3), While the correlation between serum magnesium level and serum calcium level in those patients are shown in (Figures 4,5,6).

Table 3 Relationship between some ionic levels and other parameters in male with cardiovascular disease (Myocardial infarction, heart failure, angina) and control group

Parameters	Control	MI	HF	Angina
Magnesium(mg/dl)	2.1± 0.3	1.5±0.3	1.75 ± 0.38	1.5 ± 0.3
Sodium(mEq/dl)	140 ± 3.5	149 ± 5	149.2 ± 7.2	149 ± 9.7
Calcium(mg dl)	9.3 ± 0.6	10.8 ± 0.6	10.2 ± 0.7	10.5 ± 0.8
Potassium(mEq/dl)	4.0 ± 0.3	5 ± 0.25	5.35 ± 0.4	5.3 ± 0.6
T.cholesterol(mg/dl)	197 ± 18	269 ± 21	261 ± 29	273 ± 26
Triglycerides(mg/dl)	163 ± 10	186 ± 32	183 ± 10.2	182 ± 23
LDL(mg/dl)	122 ± 15	195 ± 49	193 ± 40	190 ± 25
HDL(mg/dl)	45 ± 3.5	29 ± 5	30 ± 2.3	29 ± 5
VLDL (mg/dl)	32 ± 2	40 ± 6	37.3 ± 2.5	37 ± 2.1

Table 4 :Relationship between some ionic levels and other parameters in female with cardiovascular disease (Myocardial infraction, heart failure, angina) and control group

Parameters	Control	MI	HF	Angina
Magnesium(mg/dl)	1.9± 0.2	1.3 ± 0.2	1.6 ± 0.3	1.4 ± 0.5
Sodium(mEq/dl)	139.3 ± 4.	146 ± 4.5	145 ± 5.2	147 ± 5
Calcium(mg dl)	9.4 ± 0.5	10.7 ± 0.4	10.3 ± 0.9	10.2 ± 1.5
Potassium(mEq/dl)	4.3 ± 0.2	5.36 ± 0.35	5 ± 0.2	4.95 ± 0.9
T.cholesterol(mg/dl)	186 ± 13	258 ± 20	256 ± 27	245 ± 54
Triglycerides(mg/dl)	150 ± 8	183 ± 11	175 ± 13	174 ± 38
HDL(mg/dl)	39 ± 4	21 ± 7	27 ± 4.7	26 ± 4
LDL(mg/dl)	117 ± 13	181 ± 30	190 ± 42	172 ± 16
VLDL (mg/dl)	31.5 ± 2.3	38 ± 5	32 ± 3.4	35 ± 7

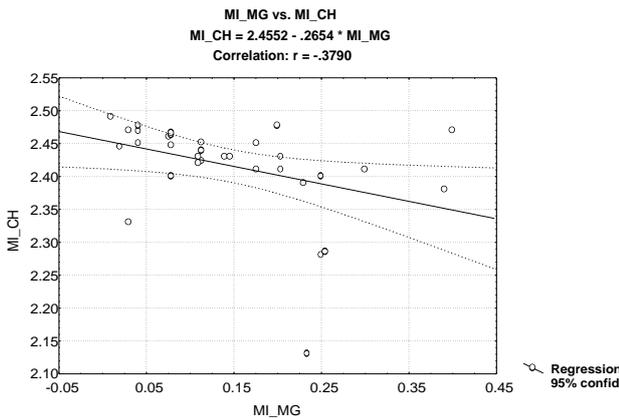


Fig.1-Relationship between serum magnesium concentration and serum cholesterol concentration in patients with MI

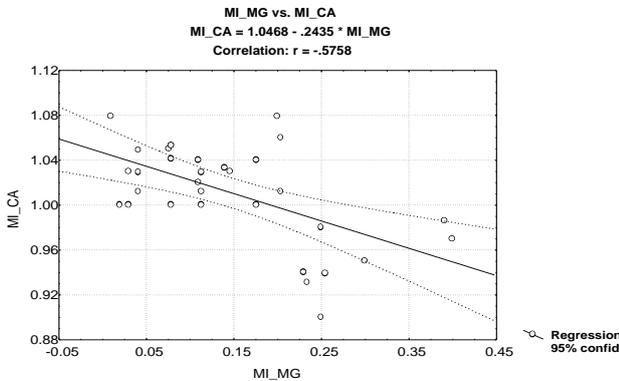


Fig.2-Relationship between serum magnesium concentration and serum cholesterol concentration in patients with HF

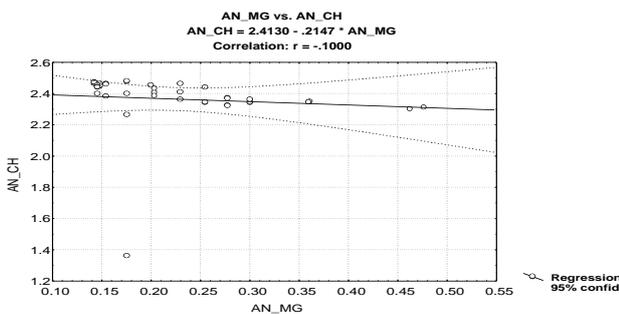


Fig.3-Relationship between serum magnesium concentration and serum cholesterol concentration in patients with Angina

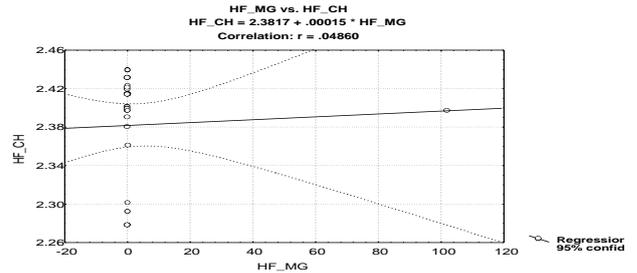


Fig.4-Relationship between serum magnesium concentration and serum calcium concentration in patients with MI

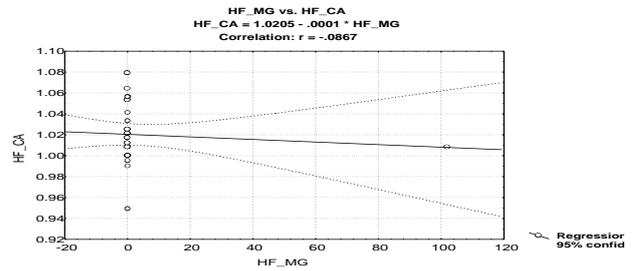


Fig. 5-Relationship between serum magnesium concentration and serum Calcium concentration in patients with HF

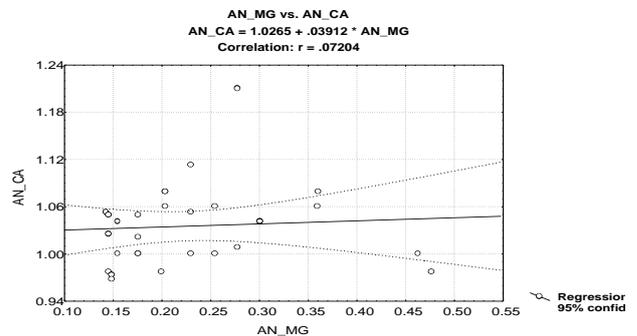


Fig.6-Relationship between serum magnesium concentration and serum Calcium concentration in patients with Angina

Discussion:

Cardiovascular diseases (C.V.D) taken together account for a major proportion of all deaths during adulthood in both developed and developing countries. The death disability and general illness resulting from cardiovascular disease is preventable to a large extent[16].

Provided the known risk factors are minimized by good life style and habits, people with two or more risk factors in their life's are much more likely to get heart disease than those with one or none[17].

A number of risk factors for C.V.D have been identified . These include hypercholesterolemia , family history of C.V.D , hypertension , obesity , diabetes , lipid profile , electrolyte levels and others[18].

In our study lipid profile (Cholesterol ,Triglycerides, LDL, Cholesterol , HDL Cholesterol and VLDL) and electrolyte levels(Mg^{+2} , Ca^{+2} , Na^{+} , K^{+}) were determined in patients with the three major categories of C.V.D (myocardial infraction , Heart failure ,and Angina) and their results were compared with the same variables of control group .

The results of this study shows that the serum calcium level was elevated in MI patients more than heart failure patients and those with Angina while serum magnesium level was low reciprocally in MI patients more than in HF and Angina patients , the decrease in Mg was significant ($P < 0.01$) in three patients groups as compared with control .

This result was agreed with ionic hypothesis which postulate that the excess of Ca^{+2} reciprocally lowers the level of Mg^{+2} which has a tissue specific effect on vascular smooth muscle leading to vasoconstriction and elevated blood pressure[19].

In addition the significantly elevated($P < 0.01$) serum calcium level associated with a significantly increase ($P < 0.01$) in serum sodium and potassium for the three groups of C.V.D.

Other parameters (total serum cholesterol, triglycerides, LDL cholesterol and VLDL). were also significantly increased ($P < 0.01$) in the three types of C.V.D , the increment of these parameters in patients with MI was more than in patients with HF and angina on the other hand there is a decrease in HDL cholesterol level in patients with MI which is more than the decrement noticed in patients with HF and angina. The elevated serum LDL -Cholesterol which act's as a carrier of cholesterol to blood vessels and decrement in serum HDL-cholesterol which acts as a carrier of cholesterol from blood vessels to the liver lead to accumulation of cholesterol in the blood vessels and then developed to atherosclerosis[20].

In this study there is a significant decrease in serum magnesium concentration in patients with MI ($P < 0.01$) as compared to control group .other electrolytes show significant increase in their concentration in both sexes ($Na^{+}/ P < 0.01$, $K^{+}/ P < 0.01$) .However serum calcium concentration was significant increased in female ($P < 0.05$) while in male the increment was non significant

($P > 0.05$) .Moreover in all above ions there were significant sex difference in patients with MI.

Our result was agreed with Agus [10] result in (2001) who proved that hypomagnesaemia is common in hospitalized patients and may contribute significantly to cardiac morbidity and mortality particularly in states associated with myocardial ischemia [20]. While it disagreed with results found by Giesecke in (1986) who suggest that magnesium level was increased in MI patients [21].

This study shows that the serum lipid highly significant differences between patients group and control group for both sex ($P < 0.01$) except triglycerids and LDL-cholesterol were highly significant in females ($P < 0.01$) and non significant in male ($P < 0.01$). While in the same patients there is a significant level between male and female for each parameters.

In regard to heart failure our results was supported by many other studies that proved the decrement of Mg^{+2} in serum of patients with heart failure[22]. This decrement is significant in our study in male and female ($P < 0.01$) .There were a significant increment in other electrolyte levels like (Na^{+} , Ca^{+2} and K^{+}) in both sex ($P < 0.05$) .In the other hand a significant increment in each parameter of lipid profile were obtained except HDL-cholesterol which show a significant decrement. These results were supported by Mukht results in 2001[23]. In the same patients a significant level ($P < 0.05$) in each parameter between male and female were obtained except Ca, cholesterol and LDL were show non significant level ($P > 0.05$).

The same result was obtained in patients with Angina that included significant low level of serum magnesium ($P < 0.01$). Our result for patients with angina was not goes with the results that found by Giesecke in (1986) which suggest that the serum magnesium level was normal in angina patients[21]. Also in these patients it was found that the serum electrolyte(Na^{+} , K^{+} , Ca^{+2}) and lipid profile was elevated except HDL -cholesterol which with significantly decrement ($P < 0.01$), this result was goes with the result that reported by Miwa [24].

Several workers reported that there is a relationship between magnesium deficiency and lipid metabolism . The increase in plasma triglycerides and cholesterol observed in magnesium deficient may be the result of increased hepatic synthesis [25]. The secondary effects of magnesium deficient including loss of potassium and accumulation of sodium and calcium which may be the result of defective membrane function could be the primary lesion underlying cellular disturbances that occur in Mg^{+2} deficiency.

This study correlate well between serum magnesium and serum calcium levels in patients with MI ($r = 0.75$) . However this correlation is poor in patients with HF and angina .Also the correlation between serum magnesium and serum cholesterol levels was weak in this study in all the three categories of CVD.

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عدم التوازن الايوني كعامل خطورة للإصابة بأمراض القلب الوعائية

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الخلاصة:

وهذا النقصان في تركيز Mg^{++} له علاقة عكسية بزيادة تركيز كل من (Na^+, K^+, Ca^{++}) .

كذلك وجد أن تركيز كل من الكوليسترول ، الكليسيريدات الثلاثية بالإضافة إلى اللايبوبروتينات واطئة الكثافة تزداد في هؤلاء المرضى وفي كلا الجنسين بينما يقل تركيز اللايبوبروتينات عالية الكثافة في النساء والرجال لأنواع الثلاثة من الأمراض القلبية الوعائية.

من هذه الدراسة نستنتج أن نقصان تركيز Mg^{++} في أمصال دم المرضى الذين يعانون من الأمراض القلبية الوعائية قد يؤثر على عملية ايض الليبيدات بالإضافة إلى تأثيره على تركيز بقية الأيونات مثل (Na^+, K^+, Ca^{++}) .

تضمنت الدراسة ١٠٠ مريضاً (ذكور واناث) يعانون من الأمراض القلبية الوعائية مثل (الذبحة الصدرية ، احتشاء العضلة القلبية ، عجز القلب) من فئات عمرية تراوحت بين (٥٥ – ٧٥) سنة هؤلاء المرضى قورنوا مع ٧٨ شخص سليم ضمن نفس الفئة العمرية . هذه الدراسة نفذت على المرضى الذين ادخلوا إلى وحدة العناية المركزة في مستشفى تكريت التعليمي في صلاح الدين .جمعت نماذج الدم من المرضى في حالة الصيام وقد قيس تركيز بعض الأيونات في مصل الدم مثل $(Mg^{++}, Na^+, K^+, Ca^{++})$ بالإضافة إلى قياس تركيز الليبيدات والليبيدات البروتينية في مصل الدم .

لوحظ أن تركيز Mg^{++} يقل في أمصال دم المرضى الذين يعانون من الذبحة الصدرية واحتشاء العضلة القلبية وعجز القلب وفي كلا الجنسين