Relationship between Serum Magnesium Levels With Incidence of Cardiac Arrhythmias in Non-diabetic and Type 2 Diabetes Patients Who Underwent Coronary Artery Bypass Graft Surgery (*CABG*)

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Abstract: Introduction: Magnesium (*mg*) depletion plays a key role in the path physiology of diabetes mellitus, cardiovascular disease, arrhythmia and cardiopulmonary bypass. ATRIAL and ventricular arrhythmias are among the most common complications after coronary artery bypass graft (*CABG*) surgery. Our objective was to detect the relationship between the level of magnesium and arrhythmia in non diabetic and diabetic patients who underwent *CABG*. **Methods:** In this descriptive, cross-sectional study, the plasma level of magnesium was measured in 434 diabetic patients who underwent CABG in NAFT Hospital of Ahwaz. Spectrophotometer was used to measure the plasma level of magnesium. Glycosylated of hemoglobin was also measured as a glycemic control index. Data were analyzed using descriptive statistics and t-test. **Results:** The mean concentration of magnesium in type 2 diabetic patients in pre and post CABG was 1.68 ± .79 and 1.37 ±.26 (p = 000). The mean concentration of magnesium in non diabetic patients in pre and post CABG was 2.53 ±1.9 and 1.93 ±.6 (p = 0.39). There were significant negative correlation (p =0.037) between levels of Mg and arrhythmia, in other hand there was significant positive correlation between levels of Mg and HbA1c (p =. 004). **Conclusion:** According to the results of this and previous studies, we recommend routine serum Mg determination and more attention to hypomagnesaemia patients to prevent further complications.

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1. Introduction

Magnesium deficiency is associated with pathogenesis and atherosclerosis progression of coronary artery disease. Relationship between hypomagnesaemia and HDL, LDL, triglycerides have shown that there is increased LDL cholesterol, triglycerides and was decrease HDL cholesterol (13).

In other words, by increasing levels of magnesium, the risk of coronary heart disease in diabetic patients decrease .A prospective studies have shown strong relationship between concentration of magnesium levels and Type II diabetes, so that in these patients diuretic osmotic more happens.

Kao (1999) in a prospective study showed increase levels of magnesium could be act as a preventive measure in atherosclerotic type II diabetic patients (17).

Diabetes is one of the most common pathological situations in which decreased levels of magnesium occur (35).

Several studies reported that in Hypomagnesaemia, instability of ATRIAL and ventricular myocardium increases (11-16).

Despite advances in surgical techniques and preoperative management, still cardiac arrhythmias including ATRIAL fibrillation, ATRIAL and ventricular premature contractions are considered as the most common complications of CABG surgery. These arrhythmias occur 24 and 96 hours after surgery. The peak incidence of these arrhythmias happens in second and third day after the operation (23-28).

Arrhythmias are one of leading cause of state hemodynamic and Thromboembolism that matter their hospitalization duration and distress cardiac surgeons, thus increased cardiac mortality (18-23).

There are several factors effect arrhythmia after surgery which are:

a. Older age,
b. Male gender,
c. Cardiac dysfunction,
d. Chronic pulmonary disease,
e. Chronic renal failure,

f. Diabetes, myocardial ischemia,
g. Electrolyte imbalance,
h. Metabolic disorders including magnesium deficiency (6, 10).

1.2. Metabolic disorders

Magnesium deficiency is considered as an independent factor after surgery. Serum magnesium in intra operative and following postoperative three days will begin to decline (27).

Approximately 80% of patients who underwent CABG operation have been experienced low serum levels of total and ionized magnesium after surgery .This reduction depended on many factors including Hem dilution, increase Catecholamine levels and increase urinary excretion (2, 23-30).

The relationship between magnesium deficiency and the incidence of postoperative arrhythmias remains still unclear, however many mechanisms in the fixed relationship between magnesium and the potential of cell membranes.

Magnesium also plays a key role in other cellular functions, including setting enzymes, aerobic energy metabolism and also responsible for exhalation (31-37).

Hypomagnesaemia after *CABG* has harmful effects on cellular processes which are related to actions of magnesium ion that cause instability of cellular activity. According to the above reasons and the lack of the researchers' were motivations of such study in Ahvaz (13).

This study was aimed to investigate the relationship between serum magnesium levels with incidence of cardiac arrhythmias in patients with non-diabetic and Type II diabetes underwent coronary artery bypass graft surgery (*CABG*).

2. Material and Methods

The cross sectional study, 434 patients underwent coronary artery bypass graft surgery *CABG*) (183 patients with type 2 diabetes and 251 non-diabetic patients undergoing open heart surgery) admitted to hospital in Ahvaz Oil Co.

We enrolled in this study patients with age of 88-86 years old. 5cc (ml) fasting blood sampling under sterile condition was obtain from all patients before and after surgery.

After separation of sera, Reagent and sample solutions were prepared to read each single sample by serum magnesium test kit pars Spectra photometric methods which were done under supervision of one person. Normal range of magnesium in the respective kits were as follows: Serum magnesium level of less than 1.5 mg dL consider as Hypomagnesaemia 1.5-2.6 mg dL normal, more than 2.6 mg dL was considered as Hypomagnesaemia. Control of blood glucose levels were evaluated during the past 3 months by Glycosylated hemoglobin measurement. Range of Glycosylated hemoglobin in the colorimeter method was respectively:

Normal range between 4.5-6.9 percent, the limit border line was between 7-9 percent and 9 percent had poor control over blood glucose. (Pars test kit). Both groups of age and gender were matched together.

Incidence of cardiac arrhythmias (heart rhythm disorder in each type) were Monitored during three postoperative days.

The duration of each arrhythmia on the monitor was characterized and reported by the specialist nurse confirmed. The purpose were of this study, arrhythmias, ATRIAL arrhythmias ventricular (ATRIAL fibrillation and premature ventricular contractions), respectively. Data was analyzed by using descriptive statistics, paired t -independent and the correlation coefficient.

3. Results

The demographic data of patients are in Table 1. Mean serum magnesium in diabetic patients before surgery was 1.68±0.79 and after surgery were 1.37 ± 0.26.

Table 1: Demographic data on study participants (*M: Male, F: Female, Di: diabetic, nDi: Non diabetic, A: Arrhythmia, T: Total, No.: Number*)

G	Vi	No., %	D_i	nD_i	T
-	Age		57.07± 9.06	55.97± 10.37	56.26± 9.69
Sex	M	No.	144	188	332
		%	79.1	74.9	76.49
	F	No.	39	63	102
		%	20.9	25.1	23.51
A	+	No.	101	107	208
		%	55.2	42.6	47.93
	-	No.	82	144	226
		%	44.8	57.4	52.07

Paired t-test with (p = 000) showed significant differences. Mean magnesium levels in patients with non-diabetic prior to surgery was 2.53± 1.9 and after surgery was 1.93 ± 0.6 .Paired t-test with (p =0.39) showed significant difference.

Mean of total serum magnesium of diabetic patients was 1.08± 0.6 and in no diabetic patients was 1.37 ±0.26 and t-test with p = 0.84 showed no significant difference. Average fasting blood glucose level of patients was 130± 62.26. Mean Glycosylated hemoglobin in diabetic patients was 7.65±0 .8.

Table 2: Mean serum magnesium in diabetic groups and non diabetic
Department of serum magnesium levels before surgery (mg_b) and postoperative magnesium (mg_a)

Group	Mg_b	Mg_a	P value Paired t
Diabetic	±0.79 1.68	1.36±1.26	0.000
Non diabetic	± 9.1 2.53	± 6.6 1.93	0.84
P value t	0.78	0.64	

Average blood magnesium showed significant positive correlation with Glycosylated hemoglobin, in other hand, there was significant negative correlation with the incidence of arrhythmias statistically. But there is no significant relationship with gender.

Table 3: Relationship between magnesium levels with some demographic variables Groups
(*HG: Glycosylated hemoglobin*)

G	Di		nDi	
Vi	R^2	*P-Value*	R^2	*P-Value*
Age	0.51	0.5	0.013	0.83
sex	-0.003	0.96	0.106	0.096
HG	*0.139	*0.004	-	-
A	**-0.136	**0.037	0.013	0.83

* *Positive and significant relationship*
** *statistically significant negative relationship*

4. Discussion

Hypomagnesaemia play key role in the pathogenesis of ischemic heart disease, cardiomyopathy and cardiac arrhythmias after heart surgery. It is Important to know that after cardiac surgery (*CABG*), patients may find hypomagnesaemia even though patients magnesium level preoperatively within the normal range (1, 21).

In addition, Magnesium deficiency has a negative effect on glucose homeostasis and insulin sensitivity in type 2 diabetic patients, therefore, Magnesium deficiency also increase a progression of symptoms such as retinopathy, thrombosis and hypertension (24)

In this study, average magnesium level in both groups of patients before surgery was normal range but after surgery was lower especially in diabetic patients underwent surgery.

In a study that was conducted by Nichols and colleagues in 2002 in London showed that correcting the magnesium level in patients underwent CABG surgery reduces ATRIAL arrhythmia - ventricular arrhythmia ($P < 0.01$) (36).

The average concentrations of magnesium in the Zurich study on diabetic patients were 0.77±0.8 mg dl. In this study 37.6 percent of diabetic patient's serum magnesium concentrations were lower than normal. While the 10.9 percent of non diabetic was patients had hypomagnesaemia (9).

Hasmn etal (1997) study in Switzerland was seen in diabetic patient's plasma magnesium significantly lower than in no diabetic patients. (0.5 m mol compared 0.53) (19).

In a 1991 study in Denmark found that 30 percent of all diabetics suffer from ***hypomagnesaemia*** (12).

In India was reported that all patients with diabetes who have normal renal function are suffering ***hypomagnesaemia*** (33).

Nagasy (1996) in Japan compared serum magnesium level in diabetic patients with non diabetic patients and concluded that diabetic patients significantly serum magnesium levels are lower (26).

Singh etal (1997), in their study concluded that dietary hypomagnesaemia the secondary complications of diabetes (32).

Results obtained in this study were similar to other studies have done in this field. And it seems that a problem of Hypomagnesaemia in patients with normal level should be considered to be more exploring by physicians and researchers.

This study demonstrated that Hypomagnesaemia is associated positively with Glycosylated hemoglobin, it is significant. In a study in Saudi Arabia on 300 patients with Type II diabetes was observed that there is significant relationship between the Glycosylated hemoglobin and hypomagnesaemia (3).

Also, a study in India found that hyperglycemia in diabetic patients inversely associated with Hypomagnesaemia and return this serum magnesium to normal with insulin administration (28).

In a study in Switzerland on 37 diabetic patients a clear positive relationship existed between hypomagnesaemia and glgcosuria (29). But a study in Texas in America between hypomagnesaemia and Glycosylated hemoglobin did not find any significant relationship (6).

Beshart (2006) in the study that conducted on diabetic patients over 90 years old find no significant statistical relationship between Glycosylated hemoglobin and hypomagnesaemia (16).

In all these studies because the relationship between Glycosylated hemoglobin or fasting blood glucose levels with moderate levels of serum magnesium that caused increase urinary excretion of magnesium . This is due to acidosis and osmotic diuresis which should be considered. In this study, gender has no effect on magnesium, but in general the serum magnesium level was higher in male diabetic patients. But in the Beshart study the average serum magnesium in diabetic patient's males was higher than in diabetic patient's females (16).

In other studies, the serum magnesium level of difference between men, women and patients with diabetes type 1 and 2 did not exist (6, 20).

More than 3 decades has marked the serum magnesium levels during cardiac bypass surgery is reduced (14-16).

The study also indicated that postoperative magnesium levels in both groups declined. In addition, incidence of cardiac arrhythmias is associated with hypomagnesaemia following cardiac surgery (*CABG*). Findings of other studies confirm the results of our study (5-8).

A lot justify causes of reducing serum magnesium after CABG surgery are rare, however, they are as following: blood, intracellular magnesium loss during surgery, myocardial hypoxia, binding magnesium ions with heparin and use of blood preservative solution in the absence of allogeneic transfusion (26).

In patients with diabetes increase magnesium deficiency could be noted by renal excretion, reducing consumption or impaired absorption of magnesium (29).

Changes of Magnesium level have significantly impact on the metabolism, cellular structure and processes. The key enzymes of metabolic pathways in mitochondrial ion transport, calcium channel activity in the plasma membrane is adenosine triphosphate, which by changes level of magnesium will be corrected (1).

5. Conclusion

Relationship between serum magnesium levels with incidence of cardiac arrhythmias in non-diabetic and type 2 diabetes underwent coronary artery bypass graft surgery (*CABG*) is very important.

If the lack of attention to these ions, diet and treatment before and after surgery, that will threatens diabetic patients with dangerous arrhythmias and insulin resistance .Therefore, this lack of attention would have serious impact on the outcomes of these patients.

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