

Hypomagnesemia versus hypokalemia in Patients with congestive heart failure: The effect of severity of the disease

Dr. Abdul - Aziz Ahmed Aziz*

Dr. Mohammad Saaed Abdul-Zahra**

Dr. Yesar MH. AL-Shamma*

Dr. Mohammad Ali Abdul-Ghafoor

*Department of physiology , Medical college University of Kufa

**Department of Medicine, Medical college University of Kufa

***C.A.B.physician, General Hospital, Tallafar

الخلاصة

الأهداف: دراسة نسب نقص البوتاسيوم و نقص المغنيسيوم لدى المرضى المصابين بقصور وظيفة القلب ولمعرفة مدى تأثير شدة المرض على مستوى هذين العنصرين في مصل الدم لدى هؤلاء المرضى
الطريقة: أجريت الدراسة على ٥٠ مريضاً مصاباً بقصور وظيفة القلب تم انتقاؤهم بصورة عشوائية من المرضى الذين ادخلوا إلى الردهات الباطنية في مستشفى ابن سينا التعليمي – الموصل/ العراق. خلال الفترة من آذار ٢٠٠٥ إلى كانون الأول ٢٠٠٥، حيث تم تقسيمهم إلى أربعة مجاميع بالاعتماد على وظيفة القلب. وعينة ضابطة مكونة من ٣٠ شخصاً من الأصحاء .

تم قياس مستوى البوتاسيوم والمغنيسيوم في مصل الدم والقذف التجزيئي للبطين الأيسر لجميع المشاركين في الدراسة. تمت مقارنة التغيرات الحاصلة في القياسات المذكورة أعلاه باستعمال اختبار أنوفا. النتائج: أظهرت الدراسة وجود نقصان ذو قيمة إحصائية معنوية في مستوى المغنيسيوم لدى مرضى المجموعة الأولى ، المجموعة الثانية ، المجموعة الثالثة ، المجموعة الرابعة بالمقارنة مع العينة الضابطة ($P < 0.0001$) ، كما لوحظ وجود نقصان ذو قيمة إحصائية معنوية في مستوى المغنيسيوم لدى مرضى المجموعة الثانية ، المجموعة الثالثة ، المجموعة الرابعة بالمقارنة مع مرضى المجموعة الأولى ($P < 0.0001$) . كما أظهرت الدراسة انخفاضاً معنوياً في مستوى البوتاسيوم لدى مرضى المجموعة الأولى ($p < 0.05$) ، المجموعة الثالثة ($p < 0.005$) ، المجموعة الرابعة ($p < 0.0001$) بالمقارنة مع العينة الضابطة . ولوحظ وجود نقصان ذو قيمة إحصائية معنوية في مستوى البوتاسيوم لدى مرضى المجموعة الرابعة بالمقارنة مع مرضى المجموعة الثانية ($P < 0.05$) . كما تبين من نتائج الدراسة وجود زيادة إحصائية معنوية في قيم القذف التجزيئي للبطين الأيسر لدى العينة الضابطة بالمقارنة مع مرضى المجموعة الأولى ، المجموعة الثانية ، المجموعة الثالثة ، المجموعة الرابعة ($p < 0.0001$) وأخيراً لوحظ وجود زيادة إحصائية معنوية في قيم القذف التجزيئي للبطين الأيسر لدى مرضى المجموعة الأولى بالمقارنة مع مرضى المجموعة الثالثة ($P < 0.05$) ، و المجموعة الرابعة ($p < 0.01$) . الاستنتاج: يستدل من نتائج الدراسة أن نقص البوتاسيوم ونقص المغنيسيوم حالة مألوفة لدى المرضى المصابين بقصور وظيفة القلب وخاصة أولئك الذين يعانون من قصور شديد في وظيفة القلب.

Abstract

Objective: The present study was designed to examine the incidence of hypomagnesemia and hypokalemia in patients with congestive heart failure (CHF) and to evaluate the effect of the severity of the disease on the plasma level of these cations.

Methods: The present study was conducted on Fifty patients with CHF who were randomly selected from the patients admitted to medical wards at Ibn-Sena Teaching Hospital/ Mosul, during the period from March 2005 to December 2005.

They were divided into 4 groups depending on severity of heart failure. The also included 30 apparently healthy volunteers as a control group. Serum potassium (S_k),

magnesium (S_{mg}), and left ventricular ejection fraction (EF%) were measured for all the participant in the study.

The difference in the mean of the studied parameters between different patient groups and between patients and control group was studied using ANOVA test.

Results: The mean of S_{Mg} was significantly higher in control group than that in group I, group II, group III, and group IV ($p<0.0001$). It was also significantly higher in group I than that in group II, group III, and group IV ($p<0.0001$). The mean of S_k was significantly higher in control group than that of group I ($p<0.05$), group III ($p<0.005$) and group IV ($p<0.0001$). It was also significantly higher in group II than that of group IV ($p<0.05$). The mean of EF% was significantly higher in control group than that of group I, group II, group III, and group IV ($p<0.0001$). It was also significantly higher in group I than that of group III ($p<0.05$) and group IV ($p<0.01$).

Conclusion: The results of this study revealed that hypokalemia and hypomagnesemia are a common finding in patients with CHF, especially in severe cases.

Introduction

Congestive heart failure (CHF) represent a major public health problem, it is the only cardiovascular disorders that has increased in prevalence in the recent years and it has been projected that heart failure will be a major cause of morbidity and mortality in the future⁽¹⁾. Congestive heart failure provides a perfect milieu for the development of electrolytes disturbances. Renal dysfunction, elevation of neurohormonal substances and diuretic therapy represent the major contributory factors⁽²⁾. The common electrolytes disturbances in CHF are hypokalemia and hyponatremia. However, hypomagnesemia is another common electrolytes abnormalities encountered in CHF although it is usually not recognized by the clinicians⁽³⁾. Magnesium is one of the most abundant cations in the body and the second most plentiful intracellularly. It plays an important role in neuromuscular activity as well as in a number of metabolic processes by acting as a coenzyme⁽⁴⁾. A considerable number of experimental, epidemiological and clinical studies are now available which point to an important role of magnesium in the etiology of cardiovascular pathology^(5,6). Abnormalities of this ion may contribute to the high cardiac arrhythmia associated with CHF, accordingly the serum magnesium concentration has been considered as an important prognostic indicator in patients with CHF⁽⁷⁾. This study is an attempt to evaluate the cause and incidence of hypomagnesemia in patients with CHF versus hypokalemia and to examine the relation of hypomagnesemia with the severity of the illness.

Patients and methods:

Fifty patients with CHF (28 males and 22 females) were included in this study. They were selected randomly from the patients admitted to medical wards at Ibn-Sena Teaching Hospital/ Mosul, during the period from March 2005 to December 2005. The patients were divided into four groups according to the New York Heart Association (NYHA) classification⁽⁸⁾. Group I (NYHA classes I) includes 11 patients (6 males and 5 females), their age ranged from 41 to 71 years with a mean \pm SD of (53.3 \pm 14.5). Group II (NYHA classes II) includes 13 patients (8 males and 5 females) their age ranged from 38 to 73 years (52.6 \pm 18.4). Group III (NYHA classes III) includes 14 patients (8 males and 6 females), their age ranged from 42 to 67 years (47.3 \pm 20.2). Group IV (NYHA classes IV) includes 12 patients (6 males and 6 females), their age ranged from 48 to 73 years (59.6 \pm 16.7) .The study also includes 25 apparently healthy

volunteers (14 males and 11females), their age ranged from 40 to 73 years (49.9 ± 17.2) as a control group.

Ten ml of venous blood was obtained from a suitable forearm vein into plain tube. The tubes centrifuged within 30 minutes, the serum then separated and kept in capped plastic tubes in deep freeze (-20°C) until analysis. Serum potassium (S_K) level is measured by flame photometer (Corning 400 England)⁽⁹⁾. Serum magnesium (S_{Mg}) is measured by atomic absorption spectrophotometer (Unicam SP9, Cambridge, England)⁽¹⁰⁾. Echocardiograph is performed for every participant in the study to determine the value of left ventricular ejection fraction (EF%) .

Statistical analysis was performed using the ANOVA test (one way analysis of variance) to examine the difference in the mean of the studied parameters in between patient groups themselves and between patient groups and control group. All values are expressed as mean \pm SD.

Results

The mean \pm SD of S_{Mg} and S_K and EF% of groupI, group II, group III, group IV and control group are shown in table 1. Eleven (22%) patients with CHF included in this study had hypokalemia, while 8 of them had hypomagnesemia, Four out of the 8 patients with hypomagnesemia had concomitant hypokalemia. The mean of S_{Mg} was significantly higher in control group than that in group I ($p<0.0001$), group II ($p<0.0001$) and group III ($p<0.0001$), and group IV ($p<0.0001$). It was also significantly higher in group I than that in group II ($p<0.0001$) and group III ($p<0.0001$), and group IV ($p<0.0001$) (figure.1). The mean of S_K was significantly higher in control group than that of group I ($p<0.05$), group III ($p<0.005$) and group IV ($p<0.0001$). It was also significantly higher in group II than that of group IV ($p<0.05$). The mean of EF% was significantly higher in control group than that of group I ($p<0.0001$), group II ($p<0.0001$), group III ($p<0.0001$) and group IV ($p<0.0001$). It was also significantly higher in group I than that of group III ($p<0.05$) and group IV ($p<0.01$).

Table 1. Mean \pm S.D. of serum level of magnesium, potassium and left ventricular ejection fraction (EF %) in Control group, group I group II, group III and group IV.

Groups	Mean \pm SD		
	S_{Mg} mmol/l	S_K mmol/l	EF %
Control	1.06 ± 0.029	4.1 ± 0.25	57.3 ± 6.0
Group I	0.85 ± 0.072	3.9 ± 0.36	41.7 ± 5.3
Group II	0.73 ± 0.067	4.0 ± 0.35	37.8 ± 7.3
Group III	0.71 ± 0.067	3.8 ± 0.31	36.1 ± 6.2
Group IV	0.67 ± 0.062	3.7 ± 0.43	34.8 ± 4.7

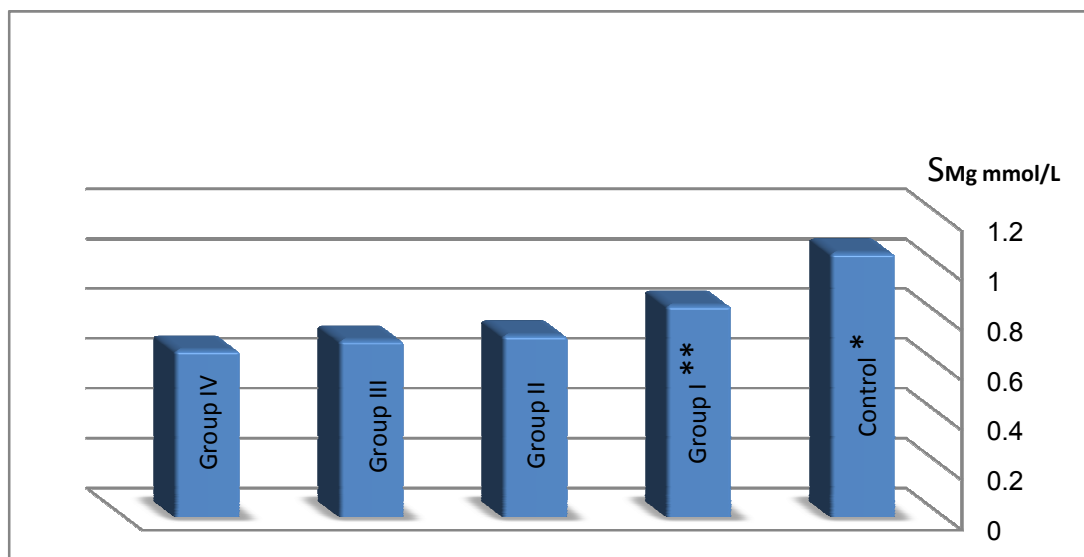


Fig. (1): Mean values of Serum magnesium (S_{Mg} mmol/L) in control and patient groups. (* significantly differ in control group from respective values in group I, II, III, and IV. ** significantly differ in group I from respective values in group II, III, and IV)

Discussion

eleven (22%) out of 50 patients with chf included in this study had hypokalemia ($s_k < 3.5 \text{ mmol/l}$). on the other hand 8 (16%) patients with chf had hypomagnesemia ($s_{mg} < 0.7 \text{ mmol/l}$), 4 out of 8 hypomagnesemic patients were hypokalemic. when patients are classified according to the severity of the disease, patients with severe chf (group iii and group iv) had the higher incidence of hypomagnesemia, and hypokalemia in comparison with mild cases (group i and ii). potassium imbalance in chf is largely due to alterations in distal renal tubule and, cortical collecting ducts handling for this ion. which in turn affected by many factors, like plasma potassium concentration it self, aldosterone, and the distal delivery of sodium and water^(11,12,13). the causes of hypomagnesemia in patients with chf is either due to increase urinary loss and or decrease intake⁽¹⁴⁾. clinically, the most common cause is the use of diuretic agents, specially the loop diuretics and to a lesser extent thiazide diuretics⁽¹⁵⁾. the kidneys maintain magnesium balance by excreting appropriate amounts of absorbed magnesium. two thirds of plasma magnesium is filtered at the glomerular level because one third is bound to the protein albumin. of the filtered magnesium, 20% to 30% is reabsorbed proximally; the major site for magnesium reabsorption is in the ascending limb of the loop of henle. it follows that potent loop blocking diuretic agents commonly used in treating chf contribute significantly to losses of urinary magnesium and potassium. in addition, altered renal hemodynamics (decreased glomerular filtration rate and a disproportionally greater decrease in renal plasma flow) result in increased filtration fraction as a consequence of heart failure^(16,17). neurohormonal activation of the renal angiotensin-aldosterone system may also contribute to magnesium depletion, perhaps because of decreased magnesium reabsorption in the proximal renal tubule from the expanded extracellular volume produced by aldosterone's effects on fluid retention^(18,19). reduced magnesium intake in patients with chf is usually develops in consequence to decrease magnesium absorption in the proximal small bowel, this area is prone to edema during the course of chf leading to impairment of magnesium absorption⁽²⁰⁾.

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