The Relationship between Serum Sodium Concentration and Atrial Fibrillation among Adult Patients in Emergency Department Settings

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Abstract

Objective: Alterations in serum levels of sodium may lead to cardiac arrhythmia by affecting the membrane potentials of cardiac cells. Previous studies have documented the association between postoperative atrial fibrillation and reduction in serum magnesium level after cardiovascular surgery well. However, there is no study assessing the relationship between serum sodium concentration and atrial fibrillation. Therefore, we aimed to investigate the relationship between serum sodium concentration and atrial fibrillation.

Material and Methods: The present study had a cross-sectional design. The study population included 240 cases (120 patients with atrial fibrillation and 120 controls). Patients with atrial fibrillation were compared with the control group in terms of serum sodium level.

Results: The mean serum sodium level in the atrial fibrillation group was 136.0±18.3 mEq/l, while it was found to be 142.0±23.9 mEq/l (p=0.04) in the control group. The mean serum sodium level in patients with permanent atrial fibrillation was 139±14 mEq/l, whereas it was 132.0±22.5 mEq/l in patients with paroxysmal atrial fibrillation (p=0.03).

Conclusion: This study indicates that low serum sodium level might be associated with atrial fibrillation. However, to obtain accurate results, new prospective studies with more patients are needed. *(JAEM 2014; 13: 131-4)*

Key words: Atrial fibrillation, serum sodium, emergency department

Introduction

Atrial fibrillation (AF) is the most common cardiac arrhythmia, which is associated with a poor prognosis and increased morbidity and mortality. The incidence of AF increases with advancing age, with an annual incidence of 0.3% in males and 0.19% in females (1). There exist some treatment approaches for AF, which include pharmacological therapy, electrical cardioversion, catheter ablation, and anticoagulation, in order to prevent thromboembolic complications (2).

The classification of AF is of paramount importance, since the treatment options will depend on the type of AF, irrespective of whether it is symptomatic or self-limited. Guidelines from the American College of Cardiology, American Heart Association, and European Society of Cardiology on the treatment of patients with atrial fibrillation recommend classification of AF into the following 3 types: paroxysmal AF, episodes of AF that self-terminate in less than 7 days and most often last less than 24 hours; persistent AF, episodes of AF that are sustained for more than 7 days and may require cardioversion by either pharmacologic or electrical intervention; and permanent AF, which is sustained beyond 1 year, as a result of either failed cardioversion or cardioversion not being attempted (3).

Certain clinical entities, such as pneumonia, chronic kidney disease, chronic heart failure (CHF), hypomagnesemia, and coronary artery bypass surgery, all of which may lead to hyponatremia, may also predispose patients to the development of AF (4-9). With the opening of sodium (Na) ion channels, Na ions fill the cells, and this changes the voltage potential of the cell, which is called depolarization. Heart muscle needs a certain amount of Na in serum to work regularly (10). We hypothesized that when the circulating levels of Na decrease, AV node depolarization cannot be done effectively, and this situation might block the inhibitor function of the AV node on accessory pathways. Therefore, the aim of this study was to investigate the relationship between serum Na level and AF.

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Material and Methods

Study Population

The study was initiated after obtaining the approval of the Clinical Research Ethics Committee (Date/number 21.06.2012/02), and all study participants gave written informed consent. The present study was designed as a cross-sectional study. Patients over the age of 18 years old who were admitted to the emergency critical care unit and had detected AF on electrocardiography constituted the study group. Those who presented to the same hospital but were not diagnosed with AF constituted the control group. Patients were excluded if there was decreased oral intake, impaired consciousness, vomiting, chronic hypertension, use of diuretics, muscle weakness, newly diagnosed epilepsy of unknown etiology, history of electrolyte disorder, alcoholism, or unwillingness to participate in the study.

Clinical Data

Baseline clinical data of the study participants, which were age, gender, systolic and diastolic blood pressures (SBP-DBP), heart rate (HR), history of CHF, chronic renal failure (CRF), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), regularly used drugs and current AF-type (paroxysmal: 7 days, short-lived, terminating in spontaneous, permanent: lasting longer than 7 days, does not convert to sinus rhythm), were collected by experienced nursing personnel.

Laboratory Analysis

A 2-ml sample of peripheral venous blood was obtained from all patients for the measurement of serum Na and was studied daily. Serum Na was measured using an automated analyzer (Integra 800, Roche Diagnostics GmbH, and Mannheim, Germany). The adjusted serum Na value was measured for patients whose blood glucose level was above 100 mg/dl.

Statistical Analysis

All results are expressed as mean and standard deviation for continuous variables and as number and percentage for categorical variables. All data were tested for normal distribution with the Kolmogorov-Smirnov test. Categorical data between treatment groups were compared by the chi-square test or Fisher's exact test. Parametric continuous data between treatment groups were compared by unpaired student t-test, and nonparametric data were compared by Mann-Whitney U-test. Pearson's correlation analysis was used to examine the possible relations between serum Na level and other parameters (age, gender, SBP-DBP, heart rate, history of CHF, CRF, DM, and COPD). A two-tailed $p<0.05$ was considered significant. All calculations were performed with Statistical Package for Social Sciences 17.0 (SPSS Inc., Chicago, IL, USA).

Results

A total of 120 patients in the AF group and 120 patients in the control group were included in the present study. In the AF group, 38 of 120 patients (31.6%) had paroxysmal AF, and 82 of 120 patients (68.4%) had permanent AF. The average age was 69±14 years in the AF group and 71±10 in the control group. A total of 158 (65.8%) of the patients were female in the study. In the AF group, 84 (70%) of the patients were female, whereas 36 (30%) of the patients were male. Age, gender, SBP- DBP, history of CAD, DM, and COPD were similar between the AF and control groups ($p<0.05$). However, CHF and CRF were more frequent in the AF group as compared with the control group ($p=0.02$, $p=0.03$, respectively). In addition, HR was significantly higher in the AF group as compared with the control group ($p<0.001$). Baseline characteristics and clinical data of the study population are summarized in Table 1.

The mean serum Na concentrations of the study population are given in Table 1. The mean level of serum Na was 136.0±18.3 mEq/l in the AF group, while it was 142.0±23.9 mEq/l in the control group ($p=0.04$). In addition, the mean level of serum Na was 132.0±22.5 mEq/l in the subgroup of paroxysmal AF, while it was 139±14.0 mEq/l in the subgroup of permanent AF ($p=0.03$) (Table 2).

There were statistically significant negative correlations between serum Na concentration and CHF, CRF, and HR (Table 3).

Discussion

In clinical practice, AF is an important cause of morbidity and mortality and is the most frequent cause of hospitalization in dys-

Table 1. The Characteristics and Serum Na Levels of the Patient and Control Groups

	AF Group (n = 120)	Control Group (n = 120)	p
Age (years)	69±14	71±10	0.1
Women n (%)	84 (70%)	74 (61.7%)	0.1
CHF	34 (40%)	8 (10%)	0.02
CAD	10 (8%)	6 (5%)	0.3
CRF	10 (12%)	2 (2%)	0.03
DM	15 (18%)	3 (5%)	0.07
COPD	23 (28%)	20 (25%)	0.4
Systolic BP (mmHg)	132±21	122±16	0.05
Diastolic BP (mmHg)	76±5	74±2	0.08
Heart rate (beats/minutes)	163±15	85±10	0.001
Serum NA level, mean, mEq/L	136±18.3	142±23.9	0.04

AF: Atrial fibrillation, CHF: Congestive heart disease, CAD: Coronary artery disease, CRF: Chronic renal failure, DM: Diabetes mellitus, COPD: Chronic obstructive pulmonary disease, BP: Blood pressure, NA: Sodium

Table 2. Serum Na levels in paroxysmal AF and permanent AF

	Paroxysmal AF (n = 38)	Permanent AF (n= 82)	p
Serum Na levels, mean±SD	132±22.5 mEq/L	139±14.0 mEq/L	0.03

Na: Sodium, AF: Atrial fibrillation

Table 3. Associations between serum Na levels and various factors in the study population

Variable	r	p
CHF	-0.52	0.02
CRF	-0.49	0.03
Heart rate	-0,93	<0.001

CHF: Congestive heart disease, CRF: Chronic renal failure

rhythmias (11). Major clinical risk factors for AF are advanced age, hypertension, CHF, DM, valvular heart disease, and myocardial infarction (12). There exist approximately 2.2 million patients with AF in the United States. The mean age of AF patients is 75 years old, and 70% of them are between the ages of 65-85 years (13). Benjamin et al. (12) found that men have a 1.5 greater risk for the development of AF when compared to women. In addition, previous studies emphasized that prevalence of AF in men was more than that of women (11). The mean age of the patients in our study was 70 years old, but conversely, the majority of patients, who were selected randomly, was female. We think that if the number of patients in the study group is extended, AF patients will increase in favor of male gender, as previous data suggested.

There is no study in the literature showing the relationship between atrial fibrillation and serum Na level. In this study, the serum Na level in the AF group was found to be significantly lower than the control group. This finding supports our hypothesis that decreased levels of serum Na may be the reason of the development of AF by blocking the inhibitor function of the AV node on accessory pathways. The serum Na level might affect the determination of AF type. Acute reductions in the level of serum Na may be the cause of paroxysmal AF episodes. In other words, the serum level of Na in the group of persistent AF, which tends to rise as a result of compensatory mechanisms but do not reach the control group Na level, may be the cause of AF by preventing the formation of phase depolarization on the AV node. In this study, patients with paroxysmal atrial fibrillation had low serum Na level than patients with permanent AF. These data also support our hypothesis.

AF shares strong associations with some diseases, such as CHF, valvular heart disease, hypertension, and CRF (5, 7). CHF and CRF are known to cause hyponatremia with various mechanisms (5-7). For instance, dilutional hyponatremia is an electrolyte disorder frequently seen in patients with CHF (7). A combined history of CHF and CRF might increase the likelihood of developing AF by decreasing serum sodium level. In this study, we found a negative correlation between serum Na value and CHF and CRF.

High ventricular rate also causes adverse hemodynamic effects in patients with AF. High heart rates lead to cardiac decompensation. One of the principle treatments of AF consists of ventricular rate control (14, 15). The relationship between ventricular rate and serum Na level has not been investigated previously. In this study, it was revealed that in the AF group, there was a strong negative correlation between heart rate and serum Na level. The reason for the high ventricular rate in patients with a low level of Na may be caused by hyponatremia, which blocks the inhibitor function of the AV node on accessory pathways.

Study Limitations

This study has several limitations, one of which was the cross-sectional design. Although cross-sectional studies can measure association, they are not strong enough to prove causality. Our sample size was relatively small. Serum sodium level may have been affected by hyperlipidemia, hyperproteinemia, or hypertonic hyponatremia associated with mannitol, glycine (posturologic or postgynecologic procedure), sucrose, or maltose. Persistent AF was not included in the subgroups of AF, since there may be some difficulties in obtaining the definite time of the onset of AF. Lastly, we did not measure other relevant biomarkers, such as antidiuretic, adrenocorticotropic, and thyroid hormones.

Conclusion

This study may be important in terms of being the first study to investigate the relationship between serum sodium level and AF. In this study, the level of serum Na level in the AF group was found to be significantly lower than the control group. This finding suggests that there might be a relationship between low serum Na levels and AF, but more studies are needed to achieve an exact result.

Ethics Committee Approval: The ethical approval was obtained from the Ethics Committee of Medical Faculty of Fırat University on 21.06.2012 with decree number 02.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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