Association between dietary salt intake and reservation of renal function in patients with mild hypertension

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Original Article

Abstract

BACKGROUND: It is now hypothesized whether restricted salt intake can be a potential precursor to renal dysfunction in mild hypertension state. We aimed to study the association between salt intake and renal function in patients with mild hypertension.

METHODS: One hundred consecutive hypertensive Iranian patients (with systolic blood pressure 140-160 mmHg and/or diastolic 90-100 mmHg) who were referred to the hypertension research center, Isfahan, Iran, between 2011 and 2014 for screening of hypertension were assessed. Renal function was assessed by measuring serum creatinine (Cr) and creatinine clearance (CrCl). Daily salt intake was assessed on the basis of 24 h urinary sodium excretion.

RESULTS: There was no association between the amounts of sodium intake and serum Cr concentration (r = 0.138, P = 0.174), however, an association was revealed between sodium intake and value of CrCl (r = 0.303, P = 0.003). Multivariable linear regression model showed that sodium intake could effectively predict renal function assessed by CrCl (Beta = 0.070, P = 0.016).

CONCLUSION: There is an association between sodium intake and reservation of renal function in mild hypertension state and thus by restriction of dietary salt intake, reserving renal function, and preventing appearance and progression of renal insufficiency in higher degrees of hypertension can be facilitated.

Keywords: Dietary, Salt Intake, Renal Function, Mild Hypertension

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Introduction

Hypertension has been still remained as the most frequent cause of cardiovascular, renal, and cerebrovascular impairment.[1] Although the overall prevalence of hypertension is now dramatically increased due to sedentary lifestyle and improper dietary regimens, because this risk factor is proposed as an asymptomatic event in about one-third of affected individuals,[1] it may be remained undiagnosed in these patients.[2] Moreover, because of the chronic nature of hypertension in most cases, its appropriate control can be naturally difficult and laborious and thus its controlling may be unsatisfactory.[3] It seems that the difficulty in hypertension treatment and control can be in order to its genetic and environmental sources. In this context, low-salt diet plays more important central role compared with drug treatment.[4] Dietary sodium restriction is a widely used method to treat hypertension in the absence of or in association with antihypertensive drugs.[5-7] This therapeutic regimen can be more effective in those with mild or moderate essential hypertension, because recent studies have suggested appropriate response to dietary salt restriction even without following a long-term treatment with anti-hypertensive drugs while considering non-pharmacological regiments in those with severe hypertension is unthinkable 8. However, the response of mild hypertension response to sodium intake restriction has been different in various populations probably due to some baseline genetic and nutritional behavioral

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factors.[8] Some studies found that reducing salt intake from 9,700 mg a day to 6,500 mg decreased blood pressure significantly in blacks, Asians, and whites who had untreated mild hypertension.[9] Besides, the effect of low-sat dietary regimen on renal function in patients with mild hypertension has been already questioned. Although long-term salt load promotes a decline in renal function in hypertensive patients and thus salt restriction is encouraged to prevent renal damage, but it is now hypothesized whether restricted salt intake can be potential precursor to renal dysfunction in mild hypertension state and thus inhibit its progression towards malignant hypertension. Herein, we aimed to study the association between salt intake and renal function in patients with mild hypertension.

Materials and Methods

In a cross-sectional population-based study, 100 consecutive hypertensive Iranian patients were selected using multi-stage cluster random sampling method. After informing the participants, one person aged 18 was selected from each household who were referred to the hypertension research center, Isfahan, Iran, between 2011 and 2014 for screening of hypertension in 2014 were included in the study. Inclusion criteria were age greater than 18 years, while exclusion criteria included history of diabetes insipid us, special dietary regimen or fasting at the day and time of sampling, history of using diuretics, history of renal insufficiency, menstruation or pregnancy, and excessive sweating during the day of urine collection. Baseline information regarding demographics, educational level, medical history, and medications were recorded. Height, weight, waist, and hip circumference were measured on the day of the visit to the clinic. Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). Blood pressure was measured twice in the left arm by an examining physician using a mercury column sphygmomanometer (Korotkoff phases I and V) after the subject had been at rest in the seated position for 5 min. Mild hypertension status was defined as systolic blood pressure 140-160 mmHg and/or diastolic 90-100 mmHg according to the World Health Organization-International Society of Hypertension Guidelines.[10] Participants fasted from the evening before the interview and collected on the day of interview a first voided urine sample into a sterile container for albumin estimation. Blood was also drawn after an 8-12 h overnight fasting period in the morning after completion of the 24 h urine collection. Plasma biochemical indices including sodium and potassium concentrations, as well as blood urea nitrogen and serum creatinine (Cr) levels, were measured by standard laboratory procedures. Renal function was assessed by measuring serum Cr and creatinine clearance (CrCl) calculated by the Cockcroft-Gault formula. This equation is often used as a method of estimating the glomerular filtration rate (GFR) from knowledge of serum Cr, age and weight as the following formula:

Creatinine clearance = [(140 - age in years) × (wt in kg)]/(serum creatinine in mg/dl × 72) that for women multiply the result of calculation by 0.85. Renal impairment was defined as a CrCl lower than 30 ml/min.

Daily salt intake was assessed on the basis of 24 h urinary sodium excretion since urinary sodium excretion largely equals sodium intake, when people are in steady state.[11] The subjects were divided into three categories according to the level of 24 h urinary sodium excretion: low-salt-intake group (n = 34, urine sodium ≤ 132 mmol/24 h), medium-salt-intake group (n = 24, urine sodium: 133-186 mmol/24 h), and high-salt-intake group (n = 42, urine sodium ≥ 187 Bmmol/24).

Kolmogorov–Smirnov test was used to check the normality of data. Results were presented as mean ± standard deviation for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. Continuous variables were compared using one-way analysis of variance and/or non-parametric Kruskal–Wallis test whenever the data did not appear to have normal distribution or when the assumption of equal variances was violated across the three groups of TR. Correlation between quantitative variables was assessed using the Spearman correlation coefficient test. Multiple linear regression analysis with the presence of confounders including those baseline variables which were univariately correlated to renal functional state (with considering P < 0.050 or less) was used to assess the value of sodium intake to predict renal function in study population. For the statistical analysis, the statistical software SPSS for windows (version 19.0, SPSS Inc., Chicago, IL, USA) was used. P = 0.050, or less were considered statistically significant.

Results

The average of the participants was 46.41 ± 12.39 years and 47% of them were men. Cigarette smoking was observed in 9% and obesity as BMI higher than 30 kg/m^2 was revealed in 33%.

As described in table1, none of the study patients had serum Cr higher than 1.07 as well as CrCl lower than 35. Considering different categories of sodium intake, the mean serum Cr level in low sodium intake group was 1.00 ± 0.19 mg/dl, in intermediate sodium intake group was 1.02 ± 0.19 mg/Dl, and in high sodium intake group was 1.03 ± 0.21 with no significant difference (P = 0.876); while, the level of CrCl was significantly increased in line with the increase of sodium intake (CrCl was 89.35 ± 26.73 ml/min in low sodium intake group, 99.38 ± 25.96 ml/min in intermediate sodium intake group, and 112.04 ± 33.02 ml/min in high sodium intake group, P = 0.006) (Table 2). The Spearman correlation test showed no association between the amounts of sodium intake and serum Cr concentration (r = 0.138, P = 0.174), however, an association was revealed between sodium intake and value of CrCl r = 0.303, P = 0.003) (Figure 1).

Table 1. Baseline characteristics in study population

Characteristics	Mean ± SD	Median	Minimum	Maximum
Age (year)	46.41 ± 12.39	47.00	21.00	76.00
Weight (kg)	76.71 ± 14.55	74.00	46.50	103.00
Height (cm)	164.44 ± 10.33	164.25	143.00	188.00
Body mass index (kg/m^2)	28.26 ± 4.22	27.79	20.36	45.64
Waist circumference (cm)	91.12 ± 10.94	89.00	69.00	136.00
Hip circumference (cm)	96.83 ± 8.15	95.50	78.50	134.00
Systolic blood pressure (mmHg)	125.18 ± 9.10	125.00	90.00	145.00
Diastolic blood pressure (mmHg)	82.90 ± 6.52	82.50	60.00	98.00
Serum BUN	15.40 ± 3.34	15.00	9.00	24.00
Serum Cr (mg/dl)	1.02 ± 0.20	1.00	0.60	1.07
CrCl (ml/min)	101.55 ± 30.82	96.76	35.27	207.21
Serum Na (mg/dl)	139.55 ± 3.16	140.00	139.00	145.00
Urinary sodium (mg/dl)	185.34 ± 80.69	178.00	38.00	402.00
Urinary potassium (mg/dl)	66.85 ± 31.24	62.00	25.00	276.00
Urinary Cr (mg/dl/100)	14.19 ± 5.10	13.07	3.25	31.99
Urinary protein (mg/dl)	50.46 ± 41.87	39.00	5.00	237.00

SD: Standard deviation; BUN: Blood urea nitrogen; Cr: Creatinine; CrCl: Creatinine clearance

Table 2. Comparing serum creatinine (Cr) and creatinine clearance (CrCl) according to the level of sodium intake

Variables	Low sodium intake	Intermediate sodium intake	High sodium intake	P
Serum Cr (mg/dl)	1.00 ± 0.19	1.02 ± 0.19	1.03 ± 0.21	0.876*
CrCl	89.35 ± 26.73	99.38 ± 25.96	112.04 ± 33.02	0.006**

* ANOVA test; ** Kruskal–Wallis test; Cr: Creatinine; CrCl: Creatinine clearance; ANOVA: Analysis of variance

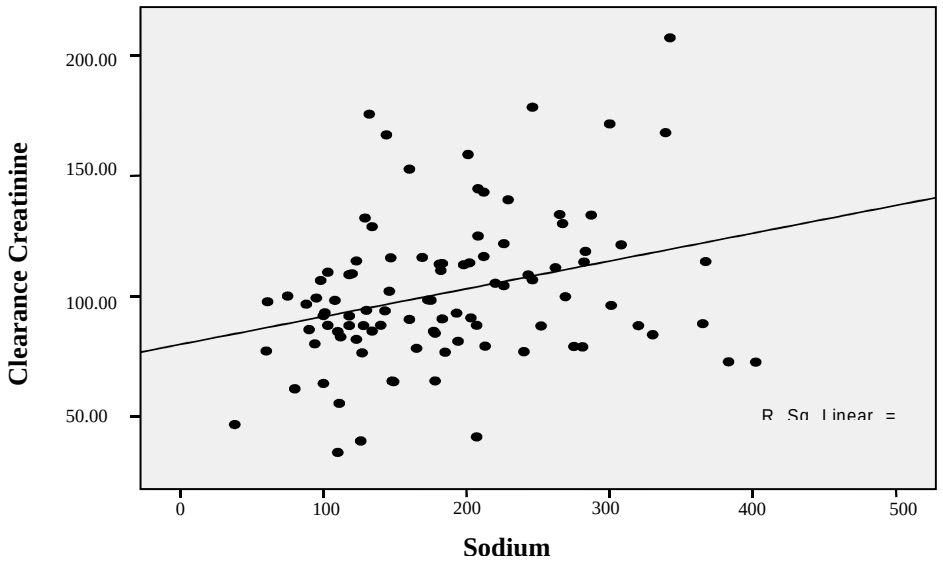

Figure 1. Association between sodium intake and creatinine clearance

Table 3. Multiple linear regression model to predict renal function (assessed by CrCl) by measurement of sodium intake

Characteristics	Univariate P	Beta	SD	Multivariate P
Sodium intake	0.002	0.070	0.029	0.016
Male gender	< 0.001	22.987	4.873	< 0.001
Age	< 0.001	-1.674	0.178	< 0.001
Waist circumference	< 0.001	-1.524	0.205	< 0.001
Cigarette smoking	0.045	-3.888	3.677	0.293
Serum Na	0.047	0.422	0.686	0.546
Systolic blood pressure (mmHg)	0.021	0.056	0.248	0.821
Diastolic blood pressure (mmHg)	0.008	-0.402	0.370	0.279

R^2: 0.650; CrCl: Creatinine clearance; SD: Standard deviation

Multiple linear regression model with the presence of confounders including gender, age, smoking, and waist circumference showed that sodium intake could effectively predict renal function assessed by CrCl (Beta = 0.070, P = 0.016). In this model, female gender, advanced age, and higher waist circumference were main determinants of low CrCl and thus renal insufficiency (Table 3).

Discussion

Numerous studies showed beneficial effects of low-salt dietary regimens on lowering and regulating blood pressure in those with mild essential hypertension. As the first aim and to the best of our knowledge, we attempted to reveal the effect of salt intake restriction on serving a renal function in patients with mild essential hypertension. In this regard, we showed a positive association between the amount of salt intake measured by assessment of urinary sodium excretion and renal functional status assessed by CrCl. On the other hand, by limiting dietary sodium intake, renal function can be reserved in those with mild hypertension. Previous studies mostly focused on this association regardless of the degrees of hypertension.[12-14] According to the confirmed effects of salt intake restriction on controlling blood pressure in those with mild hypertension and also in order to close causative relationship between high blood pressure and renal dysfunction, reserving renal function by restricting dietary sodium intake can be predictable in these patients. It is interesting to say that the pointed association can be independent of the range of blood pressure 12. As noted by Ohta et al.,[12] the association between the average salt excretion and baseline GFR was independent of blood pressure change or an increased number of antihypertensive drugs. Although bordering salt intake in hypertensive subjects can stabilize renal function in various blood pressure degrees, by preserving renal function in the early stages of hypertension, prevention of the outbreak of more serious renal adverse events following severer stages of hypertension.

For assessment of renal function state in this study, we considered two parameters of serum Cr level and CrCl, however association between sodium intake and renal function was only revealed with considering CrCl, not with serum Cr. On the other hand, among these two diagnostic parameters, CrCl can be only valid tool for assessment of renal function in mild hypertensive patients. It seems that the role of definitional components of CrCl including patient's age, gender, and body weight for predicting renal function status is fundamental. To confirm this subject, our multivariable analysis showed the central role of these indicators for prediction of renal dysfunction in mild hypertensive patients. On the other, some other predictors such as baseline proteinuria, lower serum high-density lipoprotein cholesterol,[13] black race, urea nitrogen, and phosphorus[1,4] as well as history of diabetes or urinary tract problems[15] expressed to be associated with renal insufficiency in hypertensive patients that should be considered in combination with estimation of CrCl to assess renal function in mild hypertensive subjects.

The potential limitations of the present study were the cross-sectional nature of the data, including inadequate follow-up time and hence a small sample, inability to determine effects of nutritional components and ingredients on renal function, and ignoring those with renal dysfunction as targeted population.

In conclusion, there is an association between sodium intake and reservation of renal function in mild hypertension state and thus by restriction of dietary salt intake, reserving renal function and preventing appearance and progression of renal insufficiency in higher degrees of hypertension can be facilitated. Among available criteria for

assessment of renal function in these patients, CrCl especially combined with other factors influencing renal function in hypertensive patients can be considered as the most valid tool.

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Conflict of Interests

Authors have no conflict of interests.

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