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Serum Osmolality is Elevated in Metabolic Syndrome Cases

Serum Osmolalitesi Metabolik Sendrom Vakalarında Yükselir

ABSTRACT

OBJECTIVE: It has previously been shown that renal function is impaired in metabolic syndrome (MetS). Microalbuminuria, elevated serum osmolality, and decreased glomerular filtration rate (GFR) may indicate some degree of renal impairment. Among these, microalbuminuria and GFR have already been shown to be related with MetS. This study aimed to investigate the relation between MetS and serum osmolality.

MATERIAL and METHODS: A cross-sectional case control study was designed. The study group was composed of 115 persons who were diagnosed as having MetS according to ATP III criteria and 123 persons who did not have MetS. The diagnosis of MetS was based on the presence of three or more of the following factors: hypertension; abdominal obesity; fasting serum triglycerides; low high-density lipoprotein (HDL)-cholesterol and fasting plasma glucose. Serum osmolality and GFR values were estimated by using appropriate formulations.

RESULTS: A total of 238 persons aged between 18-65 years were included in the study. MetS and serum osmolality were significantly correlated (P=0.001). Serum osmolality was also correlated with systolic blood pressure (P=0.000), fasting plasma glucose (P=0.000), and waist circumference (P=0.000).

CONCLUSION: Serum osmolality is correlated with metabolic syndrome and its parameters. The reason for increased serum osmolality values in MetS patients needs to be investigated.

KEY WORDS: Serum osmolality, Metabolic syndrome, Microalbuminurea, GFR

ÖZ

AMAÇ: Renal fonksiyonların Metabolik Sendrom (MetS) tanısı konmuş vakalarda bozulmuş olduğu gösterilmiştir. Mikroalbüminüri, yüksek serum osmolalitesi ve düşük glomerülar filtrasyon hızı (GFR) renal hasara işaret edebilir. Bunlardan mikroalbüminüri ve GFR'nin metabolik sendromla ilişkisi çalışmalarla ortaya konmuştur. Bu çalışmada MetS ve serum osmolalitesi arasındaki muhtemel ilişkiyi araştırmayı amaçladık.

GEREÇ ve YÖNTEMLER: Araştırma kesitsel bir vaka kontrol çalışma olarak planlandı. Çalışmada ATP III kriterlerine göre MetS tespit edilen 115 vaka ve MetS olmadığı tespit edilen 123 gönüllünün sonuçları değerlendirilmiştir. Serum osmolalitesi ve GFR değerleri uygun formüller kullanılarak hesaplanmıştır.

BULGULAR: Çalışmada, 18-65 yaş aralığında ardışık seçilen 238 vakanın sonuçları değerlendirilmiştir. MetS ve serum osmolalitesi istatistik olarak anlamlı düzeyde (p=0,001) ilişkili bulunmuştur. Serum osmolalitesi aynı zamanda sistolik kan basıncı, açlık plazma glükozu ve bel çevresi ile ilişkilidir.

SONUÇ: Serum osmolalitesi metabolik sendrom ve onun parametreleri ile ilişkilidir. MetS hastalarında serum osmolalitesindeki artışın sebepleri ileri çalışmalarla araştırılmalıdır.

ANAHTAR SÖZCÜKLER: Serum osmolalitesi, Metabolik sendrom, Mikroalbüminüri, GFR

Hakan DEMİRCİ[1]
Yıldırım ÇINAR[2]

1 Sevket Yilmaz Training and Research Hospital, Clinic of Family Medicine, Bursa, Turkey
2 Trakya University Medical Faculty, Department of Internal Medicine, Edirne, Turkey

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Correspondence Address:
Hakan DEMİRCİ
Şevket Yılmaz Eğitim ve Araştırma Hastanesi, Aile Hekimliği Bölümü,
Bursa, Turkey
Phone : + 90 536 896 33 30
E-mail : drhakandemirci@hotmail.com

PURPOSE

It is known that metabolic syndrome (MetS) is associated with microalbuminuria (1). Microalbuminuria is also one of the diagnostic criteria for MetS as determined by the World Health Organization in 1999. Microalbuminuria as a result of endothelial injury in atherosclerosis may lead to retinopathy and cardiac problems in patients with diabetes mellitus.

Similarly, eGFR, which is an indicator of renal failure, has been shown to be related to MetS (2-4). The value for eGFR is simply calculated using creatinine, age, and sex, and it is currently used to determine renal failure (5, 6).

Another biochemical parameter that is impaired in cases of renal failure is serum osmolality (7). Serum osmolality can be directly measured or it can be estimated by using sodium, blood urea nitrogen (BUN) and plasma glucose values. Ethanol affects serum osmolality results, and the most important variable for calculating serum osmolality is sodium. Minimal changes in osmolality are promptly regulated by arginine vasopressin release (7-9).

Plasma glucose is a common variable that is involved in MetS and serum osmolality. BUN and sodium values are tightly related to hypertension, which is one of the criteria for the diagnosis of MetS.

Therefore, MetS has been proven to be related to microalbuminuria and eGFR. In the current study, we investigated if serum osmolality, which is a renal function indicator, is related to MetS.

PATIENTS and METHODS

This cross-sectional case control study began in February 1st 2011 and ended in December 31st 2011, it lasted eleven months. The study group was composed of 115 persons who were diagnosed as having MetS according to ATP III criteria and 123 persons who did not have MetS. Simple random sampling method was used to enroll the patients. The diagnosis of MetS was based on the presence of three or more of the following factors: hypertension (systolic blood pressure ≥130 mmHg ± diastolic blood pressure ≥85 mmHg or use of hypertensive agents); abdominal obesity (waist circumference >102 cm for men and >88 cm for women); fasting serum triglycerides ≥150 mg/dL; low high-density lipoprotein (HDL)-cholesterol (<40 mg/dL for men and <50 mg/dL for women) and fasting plasma glucose ≥110 mg/dL.

Blood pressure measurements were performed by Omron M6 Comfort digital equipment after a 10-minute rest. Height, weight, and waist circumference were all measured by a physician. Weight was recorded in light clothing and height was measured in a standing position. Body mass index was calculated from the formula: weight/height^2. Waist circumference was measured at the midpoint between the lowest rib and the iliac crest.

Laboratory examinations of each participant were obtained admissions in last 6 months. Blood samples collected by each family practice unit were sent to a common laboratory and biochemical analysis was performed in Turkey. Fasting blood glucose, HDL-cholesterol, total cholesterol, low-density lipoprotein cholesterol, triglycerides, aspartate aminotransferase, alanine aminotransferase, BUN, Na, K, and creatinine analysis were performed by the Architect auto-analyzer (C16200, Abbott, USA).

Serum osmolality was estimated according to the following formula:

Osmolality = Na x 2 + glucose/18 + BUN/2.8

The eGFR values were estimated by using creatinine, age, and sex. Microalbuminuria was investigated in spot urine by using Roche™ dipsticks. The dipsticks were kept in a refrigerator at a suitable temperature until they were used. All the equipment used in the study was paid by the investigators.

Exclusion criteria were as follows: acute infections; hypertension that was not under control, a history of chronic renal failure or renal transplantation; patients older than 65 years of age and younger than 18 years of age; alcohol consumption in the last 72 hours; heavy exercise performed in the last 24 hours; urinary infection; dehydration; fever of unknown origin; malignancy; and pregnancy.

The present study was approved by the Ethical committee of the University of Trakya. Patients were informed about the study and their signed agreement documents were collected. No patients refused to cooperate for the study.

RESULTS

A total of 122 men and 116 women participated in the study. The mean age of men was 51.3 +/- 13.6 years and it was 51.0 +/- 13.4 years for women. There was no significant difference for age between sexes (P=0.873).

The relationship between renal parameters and MetS is demonstrated in Table I. There was a strong relationship between serum osmolality and MetS (P=0.001). Serum osmolality was also associated with fasting plasma glucose (Pearson's coefficient=0.261 and P=0.01), waist circumference (Pearson's coefficient=0.193 and P=0.01), and systolic blood pressure (Pearson's coefficient=0.194 and P= 0.01), which are parameters commonly associated with MetS.

The distribution of MetS parameters and comparisons between patients and controls are shown in Table II.

Microalbuminuria was detected as positive in 38 men (31%) and 38 women (32.7%).

MetS was positive in 59.1% of women and 40.9% of men, and there was a significant difference between sexes (P=0.002).

Table I: Comparison of renal parameters in patients with metabolic syndrome and controls.

	Metabolic Syndrome (n=115)	Control (n=123)	
Microalbuminuria (mg/L)	32 +/- 26	23 +/- 19	**P= 0.002**
Serum Osmolality (mOsm/kg)	294+/- 5,1	292 +/- 5,2	**P= 0.001**
eGFR (mL/min/1.73 m^2)	73 +/- 17	81 +/- 19	**P= 0.001**

Table II: Comparison of variables between patients and controls.

	Metabolic Syndrome (n= 115)	Control (n=123)	
Systolic Blood Pressure (mmHg)	139 +/- 21	120 +/- 21	**P= 0.000**
Diastolic Blood Pressure (mmHg)	85 +/- 11	77 +/- 9	**P= 0.000**
Total Cholesterol (mg/dL)	211+/-40	202+/-39	P= 0.099
HDL Cholesterol (mg/dL)	42 +/- 8	49 +/- 12	**P= 0.000**
LDL Cholesterol (mg/dL)	131 +/- 34	128+/-32	P= 0.437
Triglyceride (mg/dL)	182 +/- 65	122 +/- 94	**P= 0.000**
Fasting Plasma Glucose (mg/dL)	126 +/- 31	99 +/- 22	**P= 0.000**
Body Mass Index (kg/m^2)	30 +/- 4.3	26 +/- 3.8	**P= 0.000**
Waist circumference (cm)	105 +/- 8.7	94 +/- 11.7	**P= 0.000**

DISCUSSION

In the current study, we found that MetS was correlated with all of the three renal parameters investigated including microalbuminuria, osmolality and eGFR. It is known that eGFR and microalbuminuria are associated with MetS. We determined that serum osmolality was also associated with MetS.

Recently, it was found that both calculated and measured osmolality were related to coronary heart disease, which was diagnosed by coronary angiography (10). Evidence indicates that hyperosmolality may promote inflammation (11). Serum osmolality may be an indicator for endothelial damage.

There is a clear relationship between MetS and fasting plasma glucose, and fasting plasma glucose is a parameter that is used to calculate serum osmolality. Waist circumference and osmolality have been determined to be closely associated. Abdominal obesity is one of the diagnostic criteria for MetS.

We found that systolic blood pressure was related to serum osmolality. BUN and sodium elevations, which in turn elevate osmolality values, may result in hypertension. Medications already taken by patients to treat hypertension might have influenced the results.

There are several limitations to this study. Ideally, serum osmolality should be measured instead of calculating it. We decided to calculate serum osmolality because its measurement is not commonly performed at hospital laboratories. Another limitation of this study was that we measured microalbuminuria in spot urine. Spot urine measurements were used because it was a cheap and easy procedure.

CONCLUSIONS

Serum osmolality is associated with MetS. Fasting plasma glucose, systolic blood pressure, and waist circumference, which are included in MetS criteria, are associated with serum osmolality. Why there is an increased serum osmolality values in MetS patients needs to be investigated.

Author Disclosure Statement

The authors state that there are no competing financial interests exist.

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