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CLINICAL STUDY

Effects of Anthropometric Measurements on Renal Function

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Although the negative effect of increased body mass index on kidney has been examined, the relation between other anthropometric measurements and kidney functions has not been investigated sufficiently. This study looks at the influence of anthropometric measurements on kidney functions. Forty patients were included in the study. Patients who had increased or normal anthropometric measurements were compared by serum levels of the urea, creatinine, albumin, 24 hr urine creatinine clearance, and urinary albumin excretion rate (UAER). Of all patients, 22 (55%) had an increased body mass index (BMI), 19 (47.5%) had an increased waist circumference (WC), and 24 (60%) had an increased waist-hip ratio (WHR). Subjects with increased BMI, WC, and WHR had significantly higher levels of serum creatinine and UAER than the subjects with normal measurements. The relation between CC and BMI was statistically significant only among the anthropometric measurements (p = 0.026). The ratio of microalbuminuria was 27.3%, 21.1%, and 29.2% in persons with increased BMI, WC, and WHR, respectively. Increases of anthropometric measurements affect kidney functions negatively. However, the influence of BMI on kidney function is more prominent. For this reason; individuals with increased anthropometric measurements should be monitored closely in terms of renal functions additional to cardiovascular risk factors.

Keywords anthropometric measurement, microalbuminuria, renal function

INTRODUCTION

Obesity is a disease that arises as a result of excess body adipose tissue. Body mass index (BMI), waist circumference (WC), and waist-hip ratio (WHR) are frequently used as measurements of the assessment of obesity.[1] The prevalence of obesity is increasing worldwide, and the effects of obesity on metabolic and cardiovascular diseases are well-known.[1,2] However, it has been demonstrated in a number of studies that obesity causes functional and structural changes in the kidneys[3] and that the major association between obesity and various pathologic events is dependent on body-fat distribution.[4] It is known that advanced obesity causes an increase in systemic arterial pressure,[5] accelerates renal plasma flow,[6,7] and increases glomerular filtration[6,8] and urinary albumin excretion rates (UAER).[6,9] Furthermore, obesity accelerates the course of idiopathic glomerular diseases, such as IgA nephropathy.[10] In addition, obesity is known to be closely related to the cardiovascular disease and the precursors of chronic kidney disease, including diabetes mellitus and hypertension.[11–13]

Few studies evaluated BMI as a potential risk factor in the development of kidney disease, and available results are conflicting. BMI and central obesity were related to microalbuminuria in some[14,15] but not all[16] studies. However, the effects of other anthropometric measurements on renal functions have not been examined sufficiently. It is not clear which anthropometric measurements are more important in terms of kidney function. This study investigated the relationship between anthropometric measurements and renal function in healthy subjects.

MATERIAL AND METHODS

Forty-seven subjects with mean age of 49.5 ± 8.6 (34–62) who applied to the authors' outpatient clinic for various reasons (lumbar strain, dyspepsia, etc.) have been recruited. Exclusion criteria were hypertension (HT), type 2 diabetes mellitus (DM), hyperlipidemia, acute and chronic renal failure, infection, inflammation, pregnancy,

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stroke, ischemic heart disease, thyroid function disorders, secondary obesity (because of hypothyroidism or Cushing syndrome), or some chronic illness. There are no subjects using tobacco or alcohol. The study was performed according to the Helsinki Declaration. Ethical approval was obtained from the local ethical committee, and each subject gave written informed consent.

The BMI (body weight [kg]/height [m^2]), WC, and WHR of the subjects were recorded. The waist measurement was taken as the minimum circumference between the umbilicus and the xiphoid process. The hip measurement was recorded as the greatest circumference around the gluteal region. BMI of >30 kg/m^2, WC in women of >88 cm and in men of >102 cm, and WHR in women of >0.8 and in men of >0.90 were accepted as increased values in anthropometric measurements.[10,17]

The serum levels of urea, creatinine, total protein and albumin, 24 hour urinary creatinine, and UAER of all subjects were determined. Creatinine in the urine and blood was measured using the colorimetric method (Jaffe). Urinary albumin concentration were measured by the nephelometric method. Urine collection was performed in home. 24-hour creatinine clearance (CC) was calculated by using the formula: (urine creatinine × urine volume in 24 hours) / (plasma creatinine × 1440). UAER was considered normoalbuminuria if it was lower than 30 mg/24 h, microalbuminuria if equal to 30–300 mg/24 h, and macroalbuminuria if higher than 300 mg/24 h.

Groups with increased and normal anthropometric measurements were compared in terms of the above mentioned parameters. Data are reported as the mean ± SD. Mean differences were compared by Mann-Whitney U tests. Spearman's correlation test was also used to detect the association of anthropometrics with renal function tests. A p value < 0.05 was considered to be significant. The statistical analysis was done using the SPSS 13.0 statistical software.

RESULTS

Of all patients, 25 (62.5%) were women and 15 (37.5%) were men. Increased BMI was determined in 22 (55%) subjects, increased WC in 19 (47.5%), and increased WHR in 24 (60%) persons. The characteristics of patients are shown in Table 1. The effects of anthropometric measurements on renal function are shown in Tables 2–4.

The means of UAER in subjects with increased BMI, WC, and WHR were higher than those in subjects with normal BMI, WC, and WHR ($p < 0.001$, $p = 0.006$, $p < 0.001$, respectively). The ratio of microalbuminuria of 27.3% was found in individuals who had high BMI, 21.1% in those with high WC, and 29.2% in those with high WHR. While no subject with normal WHR had microalbuminuria, one (5.6%) person with normal BMI and three (14.3%) persons with normal WC had it. None of the subjects had macroalbuminuria.

Table 1
Characteristics of patients

Number of patients	*40*
Age (years)	49.5 ± 8.6 (34–62)
Men	15 (37.5%)
Women	25 (62.5%)
Systolic blood pressure (mmHg)	109.9 (90–120)
Diastolic blood pressure (mmHg)	70.8 (60–80)
Level of plasma glucose (mg/dL)	90.6 (78–108)

While individuals with increased BMI had a higher value of CC than those with normal BMI ($p = 0.026$), there were no significant different between groups with increased and normal WC and WHR in terms of CC.

Serum levels of creatinine in subjects with increased BMI, WC, and WHR were significantly higher than those with normal measurements ($p = 0.02$, $p = 0.013$, $p = 0.001$, respectively). There were no significant differences between subjects with normal and increased anthropometric measurements for serum levels of urea. The serum level of albumin was significantly higher only in subjects with increased WHR vs. normal WHR ($p = 0.003$), compared to those with normal anthropometrics ($p < 0.05$).

UAER was modestly correlated with WC and WHR ($r = 0.59$, $r = 0.59$; $p < 0.001$, respectively) but was strongly correlated with BMI ($r = 0.76$, $p < 0.001$). While CC was nearly correlated with WC ($r = 0.31$, $p = 0.053$), it didn't correlate with BMI and WHR ($r = 0.23$, $p = 0.15$; $r = 0.14$, $p = 0.41$, respectively).

Of all subjects, levels of blood pressure and fasting plasma glucose were in normal limits (<130/80 mmHg, 70–100 mg/dL, respectively). However, the level of systolic blood pressure in subjects with increased BMI, WC, and WHR were significantly higher than those with normal anthropometric measures ($p < 0.001$, $p = 0.004$, $p < 0.05$, respectively). On the other hand, the level of fasting plasma glucose were significantly higher in subjects with increased BMI and WC ($p = 0.013$, $p = 0.006$, respectively).

DISCUSSION

In the present study, it was demonstrated that the effect of BMI on UAER and CC was more prominent than WC and WHR. Namely, as BMI rises, UAER and CC

Table 2

The relationship between BMI and renal function tests

	High BMI subjects (n=22)	Normal BMI subjects (n=18)	Significance
Serum urea (mg/dL)	29.1	30.0	NS
Serum creatinine (mg/dL)	1.15	0.8	$p = 0.002$
Serum albumin (g/dL)	3.9	3.8	NS
UAER (mg/day)	21.7	11.4	$p < 0.001$
CC (mL/min/1.73m^2)	92.0	86.2	$p = 0.026$
Rate of microalbuminuria	27.3	5.6	NS
Systolic blood pressure (mmHg)	115.2	103.3	$p < 0.001$
Diastolic blood pressure (mmHg)	72.3	68.9	NS
Plasma glucose (mg/dL)	92.2	87.8	$p = 0.013$

BMI: Body mass index, UAER: Urinary albumin excretion rates, CC: Creatinine clearance.

Table 3

The relationship between WC and renal function tests

	High WC subjects (n=19)	Normal WC subjects (n=21)	Significance
Serum urea (mg/dL)	29.7	29.3	NS
Serum creatinine (mg/dL)	1.1	0.9	$p = 0.013$
Serum albumin (g/dL)	3.9	3.8	NS
UAER (mg/day)	20.9	13.5	$p = 0.006$
CC (mL/min/1.73m^2)	90.5	88.4	NS
Rate of microalbuminuria	21.1	14.3	NS
Systolic blood pressure (mmHg)	114.2	106.0	$p = 0.004$
Diastolic blood pressure (mmHg)	72.1	69.5	NS
Plasma glucose (mg/dL)	93.1	88.4	$p = 0.006$

WC: Waist circumference, UAER: Urinary albumin excretion rates, CC: Creatinine clearance.

Table 4

The relationship between WHR and renal function tests

	High WHR subjects (n=24)	Normal WHR subjects (n=16)	Significance
Serum urea (mg/dL)	29.6	29.4	NS
Serum creatinine (mg/dL)	1.1	0.8	$p = 0.001$
Serum albumin (g/dL)	3.9	3.7	$p = 0.003$
UAER (mg/day)	21.3	10.6	$p < 0.001$
CC (mL/min/1.73m^2)	90.6	87.6	NS
Rate of microalbuminuria	29.2	0	$p = 0.029$
Systolic blood pressure (mmHg)	112.3	106.3	NS
Diastolic blood pressure (mmHg)	71.7	69.4	NS
Plasma glucose (mg/dL)	90.3	91.1	NS

WHR: Waist-hip ratio, UAER: Urinary albumin excretion rates, CC: Creatinine clearance.

increase. Furthermore, it was determined that the relation between CC and BMI only was statistically significant among the anthropometric measurements ($p=0.026$).

The effect of BMI on renal function has been studied previously, but the available results are conflicting. BMI and central obesity were related to microalbuminuria in some[14,15] but not all[16] studies. Obesity leads to progressive renal function disorders in patients with known renal disease. Obesity, smoking, and physical inactivity are associated significantly with CKD. Men are not more susceptible to these risk factors than women.[18] Causes of renal damage related to obesity are not known completely. The mechanism responsible for renal damage in obesity has not been established;[19,20] however, it was determined that factors such as insulin resistance and/or hypoleptinemia and/or mild inflammation could be associated with renal changes.[1]

Obesity causes an increase in cardiac output and arterial blood pressure.[21,22] Renal plasma flow and glomerular filtration rates increase upon the increase in blood pressure. Renal blood flow and glomerular filtration rates were not directly evaluated in our study; however, CC only, indicative of glomerular filtration rate, was found to be increased significantly in the population with high BMI.

Chagnac et al. compared obese and normal-weight subjects, all of which had normal fasting glucose and mean blood pressure. Although fasting serum glucose levels and mean blood pressure were normal in obese subjects, they were significantly high when compared to normal-weight ones.[23] This study obtained similar results regarding the relationship between BMI and systolic blood pressure. In addition, the same relationship was demonstrated in terms of the other anthropometric measurements. Besides, fasting glucose levels were also normal in this study, though they were significantly higher in subjects with increased BMI and WC than normal subjects. Though DM and HT, the two most frequent causes of end stage renal failure, are not apparent in obese subjects, levels of fasting glucose and systolic arterial blood pressures are higher.

Microalbuminuria is a major determinant of progressive renal function loss.[24–26] Microalbuminuria frequency in obese people shows a wide distribution (7–25%) in the literature.[9,27] Basdevant et al. reported microalbuminuria prevalence in non-diabetic and non-hypertensive obese group as 2.8%.[27] In the present study, the ratio of microalbuminuria was detected at 27.3% in the increased BMI group, 21.1% in the increased WC group, and 29.2% in the increased WHR group. These values are concordant with the upper limits of the mentioned studies.

Recently, cardiac, metabolic, and renal effects of the increase in total adipose tissue and the distribution of adipose tissue are being investigated. Mulyadi et al. examined the subjects by dividing them into central (WHR women ≥ 0.81 cm, men >0.92 cm) and peripheral (WHR women <0.81 cm, men <0.92 cm) obese groups.[14] UAER and creatinine clearance in android and mixed obese subjects was found significantly high when compared to gynoid obese subjects in the literature.[9] In the present study, the significant association was demonstrated between UAER with BMI, WC, and WHR.

Kasiske et al. compared 17 patients with advanced obesity (mean body weight: 126 kg) and marked proteinuria with a control group consisting of 34 patients with similar clinical features but at normal weight (mean body weight: 68 kg). They reported that both groups were similar in terms of the amount of urinary protein excretion, but serum albumin levels were higher in the obese group in their study.[28] In this study, though serum albumin levels were also higher in persons with increased anthropometrics compared to normal subjects, only the population with increased WHR reached a significant level. This situation is reported to be possibly related to the compensation mechanism of the liver against increasing proteinuria in obese subjects.[24]

Several limitations should be considered in the study. First, renal functions could not be evaluated with more sophisticated methods, such as method of clearance of radionuclide agent or inulin. Second, the number of subjects in the study was restricted.

In conclusion, BMI is the constantly used parameter in the assessment of obesity, and it is known to have a negative impact on kidneys. In addition, increase in WC and WHR also affects renal function. Therefore, in subjects with increased anthropometric measurements, a close follow-up of kidney functions must be performed as well as the other comorbid conditions.

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