



Comparison of Body Compositions Evaluated with Bioelectrical Impedance Analysis (BIA) with Metabolic, Hormonal and Anthropometric Measurements in PCOS Patients

PCOS Hastalarında Biyoelektrik İmpedans Analizi ile Değerlendirilen Vücut Kompozisyonlarının; Metabolik, Hormonal ve Antropometrik Ölçümlerle Karşılaştırılması

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Abstract

Aim: In this study, it was aimed to compare the body composition parameters measured by BIA(Bioelectrical Impedance Analysis) and the metabolic, anthropometric and hormonal parameters of the PCOS patients with the healthy control group and to examine the effect of PCOS on body composition parameters. It is aimed to give a better direction to PCOS follow-up and treatment.

Material and Method: 23 non-obese PCOS patients were involved to this prospective study. PCOS diagnosis was made according to the Rotterdam Consensus. Anthropometric, metabolic and hormonal parameters were measured. Body compositions were measured by BIA.

Results: When the relationship between body composition parameters and metabolic and hormonal values were examined, significant correlations were found. There was a negative correlation between AUC-insulin levels and SHBG while a significant positive correlation between free testosterone in hirsute women with PCOS. There was a significant negative correlation between free testosterone level increase and body fat ratio while a significant positive correlation between SHBG and body fat ratio. There was a significant negative correlation between DHEAS and BMI and the hip circumference. When the relationship between body composition and antropometric parameters were examined, a significant positive correlation was found between BMI and body fat ratio, total body water and basal metabolic rate in women with PCOS.

Conclusion: In this study, significant correlations were found between body compositions and hormonal, metabolic and antropometric parameters in patients with PCOS. Based on these findings, we believe that BIA can play an important role in outpatient follow-up of patients with PCOS.

Keywords: PCOS, Body composition characteristics, BIA, Metabolic, hormonal and antropometric parameters

Öz

Amaç: Bu çalışmada, PCOS'lu ve sağlıklı kontrol grubu hastalarında, vücut kompozisyon parametreleri BIA (Biyoelektrik İmpedans Analizi) ile ölçülerek, metabolik, antropometrik ve hormonal parametrelerle karşılaştırılmıştır. Böylece, PCOS'un vücut kompozisyon parametreleri üzerindeki etkileri incelenerek, PCOS takip ve tedavisine daha iyi yön verebilmek hedeflenmiştir.

Gereç ve Yöntem: Bu prospektif çalışmaya 23 obez olmayan PKOS hastası dahil edildi. PCOS tanısı Rotterdam Konsensus Konferansı'na göre konuldu. Antropometrik, metabolik ve hormonal parametreler ölçüldü. Vücut kompozisyonları BIA ile ölçüldü.

Bulgular: Vücut kompozisyon parametreleri ile metabolik ve hormonal değerler arasındaki ilişki incelendiğinde anlamlı korelasyonlar tespit edildi. PCOS'lu kılıklı kadınlarda AUC-insülin seviyeleri ile SHBG arasında negatif bir korelasyon varken serbest testosteron arasında anlamlı bir pozitif korelasyon bulundu. Serbest testosteron seviyesi artışı ile vücut yağ oranı arasında anlamlı negatif korelasyon varken, SHBG ile vücut yağ oranı arasında anlamlı pozitif korelasyon tespit edildi. DHEAS ile vücut kitle indeksi (VKİ) ve kalça çevresi arasında anlamlı negatif korelasyon bulundu. Vücut kompozisyonları ile antropometrik parametreler arasındaki ilişki incelendiğinde ise, PKOS'lu kadınlarda VKİ ile vücut yağ oranı, toplam vücut suyu ve bazal metabolik hız arasında anlamlı pozitif korelasyonlar bulundu.

Sonuç: Bu çalışmada, PKOS' lu hastalarda vücut kompozisyonları ile hormonal, metabolik ve antropometrik parametreler arasında önemli korelasyonlar bulundu. Bu bulgulara dayanarak, basit ve noninvaziv bir yöntem olan BIA'nın PCOS'lu hastaların poliklinik takiplerinde önemli bir yer alabileceği kanaatindeyiz.

Anahtar Kelimeler: PCOS, Vücut kompozisyon karakteristikleri, BIA, Metabolik, hormonal ve antropometrik parametreler



INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a common reproductive and endocrine disorder characterized by hyperandrogenism, anovulation and menstrual dysfunction affecting 5-10% of women of childbearing age.^{1,2} In PCOS increased incidence of metabolic syndrome components (insulin resistance, impaired glucose tolerance and type 2 diabetes, dyslipidemia, hypertension, and cardiovascular risk profile) have been demonstrated. Obesity is present in 30-75% of women with PCOS and it is an aggravating factor for clinical entities of metabolic syndrome.^{3,4}

Currently, there is still no consensus on the etiopathogenesis and diagnostic criteria of PCOS.⁵ Since it is a chronic endocrine and metabolic disorder, it is likely that body composition will change over time. In this study, it was aimed to compare the body composition parameters measured by BIA (Bioelectrical Impedance Analysis) and the metabolic anthropometric and hormonal parameters of the PCOS patients with the healthy control group and to examine the effect of PCOS on body composition parameters that might give better direction to follow-up and treatment of PCOS.

MATERIAL AND METHOD

This study was conducted at Endocrinology Outpatient Clinic on 23 patients who were admitted by oligo/amenore, weight gain, increased body hair and infertility complaints and diagnosed to have PCOS according to the Rotterdam criteria 6 and on 20 healthy women of similar age and weight. Diabetic patients, steroid preparation users, oral contraceptive users, patients with any systemic (liver, kidney, heart) disease, patients using medicine that can affect insulin resistance for any reason, and smokers were not included in the study. Before the study, ethics committee approval was obtained from Harran University Faculty of Medicine. The standard form for data including identification information, age, height and weight, medical and gynecological history and physical examination findings has been filled.

Metabolic and Hormonal parameters

The study group received standard 75 g oral glucose tolerance test (OGTT) to assess insulin resistance. Serum glucose (mg/dl) and insulin (uIU/ml) levels were measured in these blood samples. The area under the curve (AUC) for glucose and insulin was calculated from these values by trapezoidal rule. AUC-Glucose and AUC-Insulin were used as mixed variables in data analysis reflecting blood glucose and insulin levels. The insulin sensitivity index (ISI) was calculated using the ISI-Composite formula described by Matsuda and De Fronzo, which is as valuable as the gold standard clamp technique.⁷

Triglyceride, total cholesterol, HDL-cholesterol and LDL-cholesterol values were measured in blood samples taken after at least 10 hours of fasting. Blood samples were taken between days 3 and 8 of the menstrual cycle for hormonal evaluation. TT, fT, Östradiol, PRL, DHEAS, SHBG, Cortisol levels

were measured. A 1 mg dexamethasone suppression test was performed to exclude Cushing's disease in all the patients. At 11.00 pm, 1 mg dexamethasone was applied and at 8.00 am patients with venous cortisol level of 3 mcg/dl or less were considered normal.

Antropometric parameters

At the time of initial admission Body mass indexes (BMI) in kg/m² were calculated by measuring the height (m) and weight (kg) of the patients and waist circumference, hip circumference, waist/hip circumference ratio were measured.

Body Composition Parameters Measured By Bioelectrical Impedance Analysis

In the morning of the day when anthropometric measurements were made, after at least 8 hours of rest, BIA was performed on the two groups of patients with empty stomach and empty bladder. Biodynamics BIA 450, USA, Bioimpedance Analyzer was used in the procedure. The patients were told to drink 7-8 glasses of water a day before the procedure, and not to drink much tea/coffee and not to smoke many cigarettes. The metal and decorative items on the patient and, if any, large metal clothing items (such as belts) were removed. The individual to be measured was asked to stay in supine position on the examination table with dress but without shoe and socks. For measurement, two electrodes were placed on the dorsal side of the right hand and right wrist and two electrodes were placed on the dorsal side of the right foot and the right ankle (using standard tetrapolar electrodes). Afterwards, the instrument was turned on and the required information was entered and the measurement was performed. Body fat ratio (BFR), fat mass (FM), total body water (TBW), basal metabolic rate (BMR), lean body mass (LBM) were measured by BIA.

Statistical Analysis

Anthropometric parameters, metabolic parameters and body composition parameters measured by BIA were compared between the study group and the control group. SPSS (Statistical Package for Social Sciences) for Windows 11.5 program was used for the statistical analysis. For descriptive statistical methods (Mean, Standard deviation) and for comparison of normally distributed quantitative data of study and control group Student t test was used. Man Whitney U test was used for non-normal distribution parameters. Chi-square test was used for comparison of qualitative data. Pearson correlation test was used for normal distribution parameters and Spearman's correlation test was used for non-normal distribution parameters. The results were evaluated in a 95% confidence interval and a significance level of p<0.05.

RESULTS

There were 23 women with PCOS who had a BMI of 18.91-26.93 kg/m² between 18 and 32 years (22.0±3.43), and 20 women with a BMI of 18.26-24.97 kg/m² between 17 and 33 years (24.0±4.02) were included in the study.

When we compare the hormonal and metabolic parameters, there was a significant difference in LH, TT, fT, SHBG. As to be expected, the LH, TT and fT levels were significantly higher in PCOS group while SHBG level were significantly low. Ferriman Galwey score were also significantly higher in PCOS group ($p < 0.001$). When lipid profiles, metabolic parameters were compared and there was no statistically significant difference ($p > 0.05$) (Table 1).

	PCOS Group (n=23)	Control Group (n=20)	P
FSH (mIU/ml)	4.61±1.32	5.33±4.76	>0.05
LH (mIU/ml)	12.79±6.32	6.23±3.12	<0.001
TT (ng/dl)	70.90±26.09	46.8±17.5	p=0.001
fT (pg/ml)	12.22±5.56	6.87±4.46	<0.001
SHBG (nmol/L)	40.37±21.07	75.36±60.60	<0.05
DHEAS(ug/dl)	268.52±117.85	245.34±124.05	>0.05
AUC glucose	199.16±40.96	207.22±42.39	>0.05
AUC insulin	80.67±29.64	88.21±5060	>0.05
ISI	7.06±2.79	6.66±2.64	>0.05
Basal Metabolic Speed (cal)	1264.6±20.1	1078.9±397.7	>0.05
Ferriman-Galwey Score	13.91±4.89	5.80±1.43	<0.001
Mean±SD			

Between study groups there was also no statistically significant difference in the anthropometric measurements and in the body composition components ($p > 0.05$) (Table 2).

	PCOS Group (n=23)	Control Group (n=20)	P
Waist Circumference (cm)	70.56±5.11	68.35±7.07	>0.05
Hip Circumference (cm)	94.21±7.70	92.1±9.84	>0.05
Waist/Hip ratio	0.75±0.04	0.74±0.069	>0.05
Fat Mass (kg)	14.42±4.04	14.33±2.90	>0.05
Body fat ratio (%)	26.12±5.58	26.26±5.77	>0.05
LBM (%)	40.53±6.44	38.32±5.12	>0.05
TBW (liter)	30.33±3.80	29.03±2.84	>0.05
Mean±SD			

However, when correlation of androgenemias and Ferriman-Galwey scores with BMI, body composition values, AUC-insulin AUC-glucose and ISI were examined in patients with PCOS, there was significant negative correlation between insulin sensitivity and total and free testosterone levels in hirsute women with PCOS ($r = -0.448$, $p < 0.05$, $r = -0.538$, $p < 0.01$, respectively) (Table 3). There was a negative correlation between SHBG and AUC-insulin levels ($r = -0.540$, $p < 0.01$) and a significant positive correlation between free testosterone increase and AUC-insulin levels ($r = 0.06$, $p < 0.01$).

In hirsute women with PCOS, there was a significant negative correlation ($r = -0.544$, $p < 0.01$) between free testosterone level increase and body fat ratio and a significant positive correlation ($r = 0.544$, $p < 0.01$) with lean body mass. In women with PCOS, there was a significant positive correlation between SHBG and body fat ratio ($r = 0.418$, $p < 0.05$) and a negative correlation with DHEAS ($r = -0.572$, $p < 0.01$). There was a significantly positive correlation between lean body mass and DHEAS ($r = 0.572$, $p < 0.01$). There was a significant negative correlation between DHEAS and BMI and the hip circumference ($r = -0.584$, $p < 0.01$; $r = -0.425$, $p < 0.05$, respectively). However, there was no significant relationship between free testosterone level and BMI, waist circumference, hip circumference and waist/hip ratio.

When the relationship between body composition and anthropometric parameters were examined, a significant positive correlation was found between BMI and body fat ratio, total body water and basal metabolic rate in women with PCOS ($r = 0.609$, $p < 0.01$; $r = 0.414$, $p < 0.05$; $r = 0.455$, $p < 0.05$) while the fat-free body mass showed a significant negative correlation with BMI ($r = -0.609$, $p < 0.05$). There was a strong positive correlation between total body water and waist circumference ($r = 0.616$, $p < 0.01$) and a positive correlation between total body water and hip circumference ($r = 0.491$, $p < 0.05$).

There was a strong positive correlation between basal metabolic rate (BMR) and waist circumference and hip circumference ($r = 0.646$, $p < 0.01$; $r = 0.537$, $p < 0.01$, respectively) (Table 4).

When the relationship between body composition values and metabolic parameters is examined, there was a significant negative correlation between insulin sensitivity (ISI) and total body water ($r = -0.514$, $p < 0.05$), while a significant negative correlation was found between ISI and basal metabolic rate ($r = -0.539$, $p < 0.01$). Lipid profile values and anthropometric and body composition characteristics were not significantly correlated (Table 5).

	BFR (%)	LBM (%)	TBW (%)	BMR (cal)
BMI	0.609 ^b	-0.609 ^b	0.414 ^a	0.455 ^a
Waist Circumference	0.315	-0.315	0.616 ^b	0.646 ^b
Hip Circumference	0.296	-0.296	0.491 ^a	0.537 ^b
Waist/Hip Ratio	-0.045	0.045	0.098	0.074
LH	-0.160	0.160	0.190	0.186
TT	-0.503 ^a	0.503 ^a	0.399	0.374
fT	-0.544 ^b	0.544 ^b	0.289	0.258
SHBG	0.160	-0.160	0.167	0.180
DHEAS	-0.572 ^b	0.572 ^b	0.067	0.039
AUC-glucose	-0.100	0.100	0.170	0.191
AUC-insulin	-0.254	0.254	0.405	0.405
ISI	0.137	-0.137	-0.514 ^a	-0.539 ^b
a= p<0.05	b= p<0.01			

Table 3. The association of androgenemia and Ferriman - Galwey scores with BMI, body composition values and ISI in patients with PCOS (r) (r)

	LH	TT	fT	SHBG	DHEAS	FGs
BMI	-0.038	-0.20	-0.349	0.346	-0.584 ^b	-0.393
Waist Circumference	0.062	0.007	-0.030	0.143	-0.310	-0.436
Hip Circumference	0.163	0.076	-0.074	0.182	-0.425 ^a	-0.384
Waist/Hip Ratio	-0.011	-0.202	0.066	-0.132	0.260	0.001
BFR	-0.110	-0.503 ^a	-0.544 ^b	0.418 ^a	-0.572 ^b	-0.525 ^a
LBM	-0.609	0.503 ^a	0.544 ^b	-0.018	0.572 ^b	0.525 ^a
TBW	0.190	0.399	0.239	-0.032	0.067	0.159
AUC- glucose	-0.155	0.259	0.324	-0.154	0.343	0.083
AUC- insulin	0.228	0.369	0.06 ^b	-0.540 ^b	0.422 ^a	0.126
ISI	-0.035	-0.448 ^a	-0.538 ^b	0.361	-0.282	0.089

a = p<0.05 b = p<0.01

Table 5. The association of anthropometric and body composition values with metabolic parameters (r)

	AUC-glucose	AUC-insulin	ISI	Triglyceride	Cholesterol	LDL	HDL
BMI	0.004	-0.086	-0.130	0.015	0.196	0.208	0.016
BFR	-0.100	-0.254	0.137	0.071	0.204	0.152	0.075
LBM	0.100	0.254	-0.137	-0.071	-0.204	-0.152	-0.075
TBW	0.170	0.405	-0.514 ^a	-0.60	0.103	0.090	0.096
BMR	0.191	0.405	-0.539 ^b	-0.028	0.130	0.122	0.069
Waist C.	-0.038	0.117	-0.267	-0.038	0.140	0.086	0.153
Waist/Hip	-0.155	-0.207	0.067	0.075	-0.083	-0.053	-0.134

a = p< 0.05 b = p< 0.01

DISCUSSION

In this study we found that there was no statistically significant difference in the metabolic parameters, anthropometric measurements and in the body composition components between PCOS and control group. However, when correlation of androgenemias and Ferriman – Galwey scores with BMI, body composition parameters and metabolic parameters were examined significant correlations were found.

Insulin resistance is thought to play an important role in the pathophysiology of PCOS in recent years as it is known that insulin directly affects the production of in vitro ovarian androgen and in many PCOS patients insulin resistance and hyperinsulinemia are present independent of obesity.⁷⁻⁹ In our study, a negative correlation was found between total and free testosterone levels and insulin sensitivity. In hirsute women with PCOS there was a significant positive correlation between free testosterone increase and AUC-insulin levels. Negative correlation was found between AUC insulin and SHBG levels. This supports the information in the literature about the association of hyperinsulinemia with hyperandrogenic activity. Georgopoulos et al. reported that in hirsute women with PCOS, BMR evaluated by indirect calorimetry was decreased compared with control subjects, independently of obesity and IR. Adjusted BMR was significantly decreased both in women with PCOS with or without IR and particularly in women with PCOS and IR.¹⁰ In our study, we also found that the BMR decreased as insulin sensitivity increased in patients with PCOS. We additionally found that total body water also decreased as insulin sensitivity increased in PCOS patients compared to control group.

Different publications have been reported in the literature regarding the body composition of PCOS patients. Geronikou et al. made ECW, TBW, FM, and LBM and ICW measurements in their study with BIA in adolescents with PCOS and found similar results with the control group. The fact that the study was in the adolescent age group and limited sample size may have affected the results.¹¹ However, the hormonal parameters were not studied in this study. Studies have shown that androgen excess and adipose tissue hypertrophy play a role in the pathophysiology of PCOS.¹² In our study we found some correlations between hormones and body composition parameters in hirsute patients with PCOS. As free testosterone, total testosterone and DHEAS increases, BFR decreases and LBM increases. Additionally there was a positive correlation found between SHBG and BFR which means that the increase of SHBG leads to an increased level of BFR.

Churchill et al. reported that after adjusting age and BMI, there was no significant difference in BMR between PCOS women and controls.¹³ Although age and body mass index similar groups were selected in our study, it was found that BMR increased statistically significantly as BMI increased in patients with PCOS. In these patients, it was also found that body fat ratio and TBW were statistically significantly higher. In addition, we found that as the waist and hip circumference increased in patients with PCOS, BMR and total body water increased significantly. It was found that waist and hip circumference was significantly higher in PCOS patients with higher TBW and insulin sensitivity was decreased in these patients.

On the other hand, we want to emphasize that various methods of determining body composition have been developed.

With such sophisticated methods, body composition can be determined much closer to real values. However, a significant portion of these methods (such as densitometers, CT, MRI, DEXA) are not used for routine clinical and epidemiological studies because they require expensive equipment and consumables, and are impractical.

The bioelectrical impedance analysis (BIA) method developed in recent years is a method based on determining the permeability of a weak electrical current in the human body. BFM, BFR, LBM, TBW and ratio can be determined by using the related formulas in the obtained permeability data. Studies have shown that the findings obtained with the BIA method are similar to those obtained with complex methods (densitometer, total body water calculation, etc.) so that makes use of the BIA method in polyclinic work more common.^{14,15}

CONCLUSION

In this study, we found significant correlations between the body compositions measured by the BIA and other hormonal, metabolic and antropometric parameters. In future, we believe that BIA, which is a simple and noninvasive method, can take an important place in the outpatient clinic follow-up of patients with PCOS.

ABBREVIATIONS

AUC: Area under the curve, BFM: Body fat mass, BFR: Body fat ratio, BIA: Bioelectrical impedance analysis, BMI: Body mass index, BMR: Body mass ratio, DHEAS: Dehydroepiandrosterone sulfate, FGs: Ferriman-Galwey score, FSH: Follicle-stimulating hormone, fT: Free testosterone, HDL: high-density lipoprotein, ISI: Insulin sensitivity index, LBM: Lean body mass, LH: Luteinizing hormone, LDL: Low-density lipoprotein, OGTT: Oral glucose tolerance test, PCOS: Polycystic Ovary Syndrome, SHBG: Sex hormone -binding globulin, TBW: Total body water, TT: Total testosterone

ETHICAL DECLARATIONS

Ethics Committee Approval: Ethics committee approval was obtained from Harran University Faculty of Medicine (06/29.03.2007).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

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