Polycystic Ovary Syndrome: The Correlation Between Renal Doppler Ultrasound and Laboratory Parameters

Polikistik Over Sendromu: Laboratuvar Parametreleri, Renal Doppler Ultrasonografi İlişkisi

Renal Doppler Ultrasound, Polycystic Ovary Syndrome

Elif Karadeli[1], Ayla Uckuyu[2], Faika Ceylan Ciftci[2], Erzat Toprak[2], Erdem Turhan[2], Emel Ozcimen[2], Emin Alp Niron[1]
[1]Department of Radiology, [2]Department of Obstetrics and Gynecology, Baskent University, Faculty of Medicine, Turkey

Özet

Amaç: Tansiyonu normal olan üreme çağındaki polikistik over sendromlu (PKOS) kadınlarda sağ ve sol böbrek uzunluğu, parankim kalınlığı, renal arteriyel, venöz kan akımı ölçümlerinde farklılık olup olmadığını araştırmak. Gereç ve Yöntem: Rotterdam kriterlerine göre PKOS tanısı almış 40 kadın olgu ve 36 sağlıklı kadın olgu çalışmaya dahil edildi. Hormonal, biyokimyasal analiz, renal Doppler ultrasonografi yapıldı, sağ ve sol böbrek uzunluğu, parankim kalınlığı, pik sistolik velosite (PSV), rezistiv indeks (RI) ,venöz impedans indeksi(VI), insülin rezistansı, bozulmuş glikoz toleransı, serum lipid konsantrasyonu araştırıldı. Student t testi ve pearson korelasyon testi istatistik analiz için kullanıldı. Bulgular: Böbreklerin ölçümleri açısından PKOS'lu ve sağlıklı kadınlar arasında fark yoktu. Ana renal arterin pik sistolik velositesi PKOS'lu grupta daha düşüktü. Ana renal venöz impedans PKOS'lu grupta kontrol grubundan daha yüksekti. Ana renal rezistif indeks PKOS'lu grupta daha yüksekti, fakat istatistiksel olarak önemli değildi. Tüm olguları içeren bivariate analizde, ana böbrek uzunluğu, ana parankim kalınlığı ölçümleri ile BMI, bel kalça oranı, serum açlık glikoz, insülin, LDL, tirgliserit seviyeleri pozitif ilişkiliydi. Tartışma: Biz PKOS'lu normotansif üreme çağındaki kadınlarda böbrek kan akımında değişiklikler olduğunu bulduk . Bu bulgular PKOS'un uzun önem renal ve kardiyovasküler komplikasyonlarının sonucunu gösteriyor olabilir.

Anahtar Kelimeler

Doppler Ultrasonografi; Polikistik Over Sendromu

Abstract

Aim: To investigate whether there is alteration both right and left kidney lenght, parenchymal thickness, renal arterial,venous blood flow measurements in normotensive reproductive age women with polycystic ovary syndrome (PCOS). Material and Method: Forty women with PCOS according to Rotterdam criteria and thirty-six healthy volunteers women were included in our study. Hormonal, biochemical analysis, renal Doppler ultrasonography were performed and were investigated in terms of both left and right renal lenght, parenchymal thickness, peak systolic velocity (PSV), resistive index (RI), venous impedance index (VI), metabolic characteristics having insulin resistance, impaired glucose tolerance, serum lipid concentration. The student t test and pearson corelation test were used for statistical analysis. Results: The measurements for kidneys were not different between women with PCOS and healthy women. The peak systolic velocity of mean renal artery was lower in PCOS group. The mean renal venous impedance also was higher in PCOS group than control group. The mean renal resistive index was slightly higher in PCOS but not statistical significant. In bivariate corelation analyse including all patients, it was seen that BMI, WHR, level of serum fasting glucose, insulin, LDL, trigliserides were positively related with mean renal length and mean parenchymal thickness measurements. Discussion: We found that there was alterations kidney blood flow in normotensive reproductive age women with PCOS. This findings may indicate results of long term renal and cardiovascular complications of PCOS.

Keywords

Polycystic Ovary Syndrome; Renal Doppler Ultrasound

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Corresponding Author: Elif Karadeli, Department of Radiology, Baskent University, Faculty of Medicine, Adana, Turkey.
T.: +90 3223272727 F.: +90 3223271274 E-Mail: elifkaradeli@gmail.com

Introduction

Polycystic ovary syndrome (PCOS) is one of the most common endocrinopathies in women of fertile age and affects up to 6–7% of this population [1] . Using the Rotterdam consensus criteria could increase the prevalence of PCOS by at least 65%. PCOS according to Rotterdam consensus criteria should be defined by the presence of at least three to two (1- chronic anovulation 2-clinical and/or biochemical hyperandrogenism 3- polycystic ovaries on ultrasound) with the exclusion of other androgen excess or related disorders [2]. It has been recognized that PCOS is associated with metabolic abnormalities such as insulin resistance, dyslipidemia, chronic low-grade inflammation, and arterial hypertension[3]. Recently, most studies have linked PCOS with a potentially increased risk of cardiovascular disease [4].

Hypertension has a high prevalence in woman with PCOS in the perimenopausal period. Metabolic disturbances is expected to be less common in the phenotypically heterogenous group of PCOS patients diagnosed by Rotterdam criteria.

Overall, of major concern is to what extent the PCOS-related metabolic abnormalities translate into increased cardiovascular (CV) morbidity and mortality in these women. Recent data in postmenopausal women show that PCOS is associated with an increased rate of CV events, which is partly independent of the presence of obesity, diabetes and MS, and partly dependent on the degree of hyperandrogenemia [5] Thus, the burdens of CV risk conferred by PCOS and by MS, respectively, appear to be not identical, but additive. PCOS emerges as an independent predictor of CV complications after menopause.

PCOS long term consequence lead to hypertension, atherosclerosis, proteinuria. It was reported previously that first finding of impared renal function was variance of renal hemodinamics [6]. As is known, B-mode ultrasonography is stil first radiologic method in the evaluation of native renal dysfunction. Renal length, cortical thickness and parenchymal echogenicity and collecting system dilatation are examined. In spite of these parameters correlate well with hystopathology, usually, these values may help in assesment disease chronicity rather than hystopathology[7]. Since 1980-1990 years, renal Doppler sonography has been used primarily for the screening of renovascular disease in native and transplant kidneys [8] .

Doppler sonography is a nonivasive method of evaluation of local vascular resistance, such as resistance index [RI). Especially, renal RI values are useful for the assesment of renal parenchymal damage and may provide a reliable parameter of renal atherosclerosis [9]. In addition, RI values of intrarenal arteries gives information about severity of target organ damage in diseases as hypertension, diabetes mellitus and chronic renal failure [10].

The purpose of the present cross sectional case-control study was to compare between women with PCOS and healthy control and make correlations the Doppler parameters of renal artery, the interlobar arteries, renal vein including synchronously obtained serum glucose, insulin, lipid levels, other parameters.

Material and Method

In this study, after the evaluation of medical history, physical / gynecologycal examination and transvaginally ultrasonography was performed. The diagnosis of PCOS was made according to the criteria of the Rotterdam ESHRE ASRM- sponsored PCOS consensus workshop group (2004) where 2 out of 3 criteria were present: 1- oligo and/or anovulation (menstrual cycle between 35-50 days or secondary amenorrhea and/or anovulation); 2- clinic and/or biochemical signs of hyperandrogenism [Ferriman-Gallway modified score ≥8 and/or acne, and /or hyperandrogenemia: total testosterone (T) >0,6 ng/ml (2 nmol/l); 3- polycystic ovaries (PCO), identified by transvaginal ultrasonography (presence of ≥12 follicles in each ovary, measuring 2-9 mm in diameter and/or increased ovarian volume>10cm^3) [2].

This study was approved by Baskent University Institutional Review Board and Ethics Committee (Project no: KA09/262) and supported by Baskent University Research Fund. After receiving local ethical approval, written informed consent was obtained from all patients before enrollment. Patients had no pregnancy. None of the patients had any other chronic kidney, systemic, endocrin disease such as Type 2 Diabetes mellitus or hypertension, the basis of clinical history and physical examination, routine blood tests. None of the patients had pharmacological treatment for PCOS-related disorders, including oral contraseptive, antiandogenic drugs, insulin sensitizer drugs, antiplatelet drugs. Smoking patients were excluded. Clinic blood pressure (BP) measurements were performed with a mercury phygmomanometer. Patients having hypertension is defined as systolic BP greater than 140 mm Hg and/or diastolic BP greater than 90 mm Hg were not included in the study. Women having previous history of kidney stone, kidney operation, pregnancy induced hypertention were excluded.

Ultrasonography was performed by 6,5mHz micro-convex transvaginal probe (Voluson 730 Pro, General Electric Co,USA). Ultrasound examination was carried out on second or thirth day of natural menses. Follicle which is smaller than 10mm diameter was countered. Antral follicle count (AFC) were recorded totally for both ovary. Hormone profile (luteinizing hormone (LH), Total testosterone, free tetosterone, tiroid stimulan hormone (TSH), insulin), and biochemistry profile (Fasting Glucose, HDL, LDL, Triglyceride, OGTT (75g)) were performed on the same day with ultrasound evaluation. Renal Doppler evaluation was also performed on the same day with other procedurs.

Anthropometric measurements were obtained at the umbilicus (waist circumference) and at the most prominent buttock level (hip circumference); their ratio (waist-to-hip ratio, WHR) was considered as a measure of body fat distribution. Insulin resistance was calculated using the HOMA index. HOMA index was calculated as: [fasting plasma insulin (μU/ml) × fasting plasma glucose (mmol/l)]/ 22.5. As we obtained glucose levels in g/dl, we had to multiply our data by 0.055 to change them to mmol/l for the calculation of HOMA index [11].

Laboratory Analysis

A blood venous sample was obtained after an overnight fasting to assess biochemical data.

Fasting glucose, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and triglyceride (TG) levels were measured with original kits using an Abbott-Aeroset autoanalyzer (Chicago, IL, USA). Serum levels of FSH, LH, insulin

were measured by microparticle enzyme immunoassay method (MEIA) in an AXSYM autoanalyzer. Serum total testosterone levels were measured by solid-phase competetive chemiluminescent enzyme immunassay in an Immulite 2000 autoanalyzer using BIODPC reagents.

Renal Doppler Ultrasonography

All patients with polycystic overian syndrome and healthy control subjects were examined by B-mode and duplex Doppler ultrasound using a commercially avaliable colour doppler scanner (Sonoline Antares, Siemens, Germany) with a 5 MHz convex probe. All examinations were performed with the patient in the fasting state after 30 minutes of rest. Both kidneys were scanned in all women in the lateral decubitus position. All examinations were performed by the same radiologist to avoid interobserver variability. Cortical thickness and long axis of kidney were meausured and parenchyma echogenicity was determined.

Doppler spectra were obtained from the arcuate arteries at the corticomedullary junction. The Doppler angle was maintaned between 30 and 60 degrees to correct for the angle between the axis of the beam and the vessels. At least three resistive index (RI) measurements were obtained in the lower pole, midportion, and upper pole, then were averaged for each kidney at each session. The peak systolic velocity and resistive index (RI) of both main renal arteries and the peak venous flow signal and least flow signal of both main renal veins were calculated. Cortical thickness, echogenicity , and intrarenal RI values, peak systolic velocity and RI values of the main renal artery, peak venous velocity and least venous velocity were recorded in each of the kidney in all patients with polycystic overian syndrome and healthy control subjects. Venous impedance index was calculated as: (peak venous velocity- least venous velocity) / peak venous velocity .

Statistics

Statistical analysis were performed using SPSS 10.0 (SPSS for Windows 10.0; Chicago, IL, USA). Groups were compared using student t test. When parametric tests were not appropriate, Mann-Whitney U test was used. For the analysis of categorical variables, we used the x2 test and Fisher exact test, where available. Pearson's correlation analysis was used to test univariate relations. A p value <0.05 was considered significant.

Table1. Anthropometrical characteristics of PCOS and control group.

characteristics	PCOS group N:40 Mean ±SD	Control group N:36 Mean ±SD	P value
Age (year)	26,43±4,76	28,034,03±	,117
BMI	28,93±6,73	29,03±3,56	,855
Waist Circumference (cm)	84,85±13,81	82,83±7,04	,635
Hip Circumference (cm)	108,35±14,50	107,53±9,43	,868
WHR	,78±,04	,77±,03	,768
Systolic BP (mmHg)	120,67±10,21	118,89±8,45	,687
Diastolic BP (mmHg)	81,56±4,59	79,34±5,13	,876

Legend 1: BMI: Body mass index, WHR: Waist-to- hip ratio, BP: Blood pressure

Results

There was not significant difference between PCOS and control groups in terms of age, body mass index (BMI), waist-to-hip ratio (WHR), systolic and diastolic blood pressure (BP) [Table 1]. The rate of hirsutism/acne, oligomenorrhea, impaired glucose tolerance (IGT) and serum LH level and ovarian AFC in second day of cycle and serum total testorone were higher in with PCOS women than control healty women [Table 2].

Table 2. Clinic and biochemical characteristics of PCOS and control group

Characteristics	PCOS group N:40 Mean ±SD	Control group N:36 Mean ±SD	P value
Fasting Glucose (mg/dl)	93,93±6,02	91,42±6,69	,092
Insulin (µU/ml)	10,72±4,36	9,29±3,57	,122
HOMA index	2,45±,97	2,08±,82	,077
Total Testosterone (ng/ml)	,738±,30	,54±,16	,001
Free Testosterone (pg/ml)	1,58±,76	1,27±,68	,056
HDL (mg/dl)	47,35±8,96	51,97±7,71	,018
LDL (mg/dl)	108,53±24,68	120,06±18,7	,024
Triglycerides (mg/dl)	116,65±59,34	109,47±37,61	,527
TSH (µU/ml)	3,03±4,68	1,81±,50	,110
LH (mIU/ml)	8,80±5,71	4,70±1,11	,000
CRP (mg/dl)	3,68±2,31	2,85±2,02	,115
AFC	54,10±25,54	18,19±5,94	,000
Hirsutism or acne (%)	34,2	5,3	,000
Oligoamenorrhea (%)	44,7	6,6	,000
IGT (%)	2,6	9,2	,082

Legend 2: Student t test, HOMA index, homeostasis model assessment index: HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TSH: thyroid-stimulating hormone, LH: (in second day of cycle), CRP: c-reactive protein, AFC: Antral follicle count (in second day of cycle), IGT: Impaired glucose tolerance.

1- Kidneys size: There was no difference between the right renal length (RRL) (107,1mm) and the left renal length (LRL) (106,9mm). Both kidneys length were slightly lower (statistically nonsignificant) in PCOS women [Table 3]. Both lengths correlated significantly and positively with BMI, WHR, fasting glucose, insulin, HOMA, LDL.

2- Kidneys parenchymal thickness: Right and left kidney parenchymal thickness had similar patterns (respectivelly 13,84mm and 14,04mm). Both kidney parenchymal thickness also had no difference between two groups (Table 3). Both kidney parenchymal thickness correlated significantly and positively with BMI, fasting glucose, insulin, HOMA, trigliseride.

3- Kidney arteries PSV: There was no difference between right and left renal arteries PSV (respectivelly 94,8cm/sec; 95,7cm/sec p>,05). In women with PCOS, average renal PSV and left renal PSV were significantly lower than healty women (respectively p=,001, p=,015) (Table 3). PSV correlated significantly and negatively with insulin, HOMA [Table 4].

3- Kidney arteries RI: There was no difference between right and left renal arteries RI (respectivelly 0,636; 0,629 : p>,05). In women with PCOS, average renal RI was slightly higher than healty women (statistically unsignificant) (p=,062). RI correlated significantly and positively with insulin and HOMA, negatively HDL (Table 4). Mean RI of upper, middle, bottom lobar renal arteries were not difference between two groups.

4- Venous impedance (VI) index: Right and left kidney veins had different impedance index (respectivelly 0,48; 0,41 p<,05). In women with PCOS, average renal VI index and left renal VI in-

dex were significantly higher than healty women (respectively p=,009, p=,007) [Table 3].

Table 3. Comparison of arterial and venous blood flow parameters and renal biometric measurements right and left kidney in PCOS and control groups.

	PCOS group N:40 Mean±SD	Control group N:36 Mean±SD	95% Confidence Interval of the Difference	P value
Right Renal Length (mm)	106,40±7,11	107,94±8,07	-1,95- 5,04	,382
Left Renal Length (mm)	106,88±9,75	107,06±8,02	-3,89- 4,25	,930
Mean Renal Length (mm)	106,63±7,7	107,50±7,05	-4,2- 2,5	,613
Right Parenchyma Thickness (mm)	13,58±1,85	14,14±2,01	-,32- 1,45	,210
Left Parenchyma Thickness (mm)	14,38±2,33	13,67±1,62	-1,62- ,20	,127
Mean Parenchyma Thickness (mm)	13,97±1,4	13,90±1,6	-,63- ,78	,203
Right Renal RI	,64±,06	,62±,05	-,048- ,003	,089
Left Renal RI	,64±,05	,61±,05	-,044- ,001	,067
Mean Renal RI	,64±,04	,62±,04	-,00049- ,040	,062
Right Renal PSV (cm/sec)	92,85±28,12	97,00±23,00	-7,55 -15,85	,482
Left Renal PSV (cm/sec)	87,40±21,71	105,11±23,25	7,38 - 28,03	,001
Mean PSV (cm/sec)	90,12±20,21	101,05±17,80	-19,6- -2,24	,015
Mean Upper Lobar Renal Artery RI	,58±,05	,60±,03	-,038- ,003	,106
Mean Middle Lobar Renal Artery RI	,61±,05	,62±,04	-,025- ,018	,770
Mean Bottom Lobar Renal Artery RI	,62±,04	,62±,03	-,021- ,017	,855
Right Venous Impedance Index	,50±,17	,47±,15	-,106- ,043	,410
Left Venous Impedance İndex	,46±,17	,36±,15	-,180- -,308	,007
Mean Venous Impedance Index	,48±,12	,41±,09	,017- ,11	,009

Legend 3: RI: Resistive index, PSV : Peak systolic velocity,

Discussion

PCOS is a metabolic disorder which have contraversial definition yet. PCOS may cover to the differ extends of the glucose and lipid metabolism abnormalities. Obesity is common in PCOS and affects between 30–70% of women depending on the setting of the study and the ethnical background of the subjects. In Western society, incidence and prevalans of overweight/obesity increase recently [12]

Our population also have included large amount overweight women who have average BMI was 29. The overweight/obesity lead to impaired glycemic control and insulin resistance.

There is evidence concerning the relationship between renal dysfunction and cardiovascular risk in non-diabetic patients. Even minor renal dysfunction causes a dramatic increase in cardiovascular risk. PCOS not only is a reproductive endocrinopathy but, like the metabolic syndrome, is associated with long-term health risks including insulin resistance, diabetes mellitus, dyslipidemia, hypertension, and premature atherosclerosis [13]. Based on the prevalence of these risk factors, PCOS patients have an estimated 4–11-fold increased risk for coronary heart disease[14] . Epidemiologic studies have documented that diabetes and hypertension are the major risk factors for the development and progression of chronic kidney disease (CKD)[15,16]. Chen et al suggested that the insulin resistance and concomitant hyperinsulinemia are presented in CKD patients without clinical diabetes [17]. They also suggest that even mildly elevated blood pressure (130/85 mm Hg) or serum glucose levels (110 mg/dL) are associated with an increased risk for chronic kidney disease and microalbuminuria [18] .

In recent years, advanced ultrasonography transducers have led to inreased tissue information and spatial and contrast resolution. Consequently, these improvements simplified to evaluation of renal anatomic details as dimension, thickness and echogenicity of the renal cortex. These morphologic parameters are important, because ultrasonography shows findings of irreversible renal parenchymal disease as decrease in renal size, parenchymal atrophy, sclerosis and fibrosis [7]. In addition, it can help to assess prognosis and avoid unnecessary diagnostic or therapeutic procedures. Especially, this radiologic method show a smaller kidney with parenchymal atrophy is diabetic nephropathy, the leading cause of chronic and end-stage renal failure in developed countries in recent years [19].

To our knowledge, there is no study investigating renal size measurements in women with PCOS. Whereas, the studies related to the normal ultrasonographic measurements of the kidney in adult volunteers has been reported by Emamian SA et al [20]. They demonstrated that renal dimensions and parenchymal volume were correlated with age, height, weight, body mass index, and total body area. Median renal lengths were 11.2 cm on the left side and 10.9 cm on the right side. Renal size decreased with age, almost entirely because of parenchymal reduction. Renal length decreased with age and the rate of decline accelerates alter 60 years of age. Renal volume correlated best with total body area. Renal length correlated best with body height [21]. It was known that there is a trend both for the right and left kidney longitudinal lengths to increase until reptoductive age .

Enamian et al demonstrated that renal size unchange in normal situation. In our study, renal size, cortical echogenicity and parenchymal thickness of all kidneys were normal. There was no difference between the right renal length (RRL) and the left renal length (LRL) . Both right and left kidney length were slightly lower (statistically nonsignificant) in women with PCOS (Table 3).

Color Doppler ultrasonography is noninvasive method for assesment renal vascular function. It meaures blood flow velocity in the renal circulation within small parenchymal arteries. The resistive index (RI) shows vascular resistance and increase of this value demonstrates diseases of tubulointerstitial or vascular system. As is known, RI is an age-dependent parameter. Bude et al showed that RI in patents older than 60 years tends to be higher than in younger adults [22].

The peak systolic velocity (PSV) is direct proportional with flow volume (left ventricle beat volume). In addition, PSV is inversely

proportional with vascular diameter and elasticity of blood vessel wall. The normal frequency spectrum presents the typical form of a flow pulse, with low subsequent vascular resistance. In adults, the normal PSV is average 120 ±12 cm/sec (100–180 cm/sec) and the end-diastolic flow velocity is 20-50 cm/ s [8,23]. The kidneys offer a low resistance vascular bed, thus the Doppler spectral waveform from the normal kidney is that of a constant forward diastolic flow. In renal parenchymal disease, there is increase vascular resistance which in turn causes a decrease in the diastolic flow component and increased pulsatility of the Doppler spectral waveform. Parenchymal diastolic flow velocities less than 20 per cent of the peak systolic velocity are consistent with renal parenchymal disease. In renal artery stenosis, the PSV shows an increase of more than 150cm/sec. When vascular resistance is low, peak systolic velocity and peak flow volume increase with increasing blood pressure. Spontaneous variations in subject's systolic blood pressure were positively correlated with peak systolic volume and peak flow volume. Low resistance flow is blood pressure dependent [24]. Decreased PSV could show inceased vascular resistance. We found the lower PSV in PCOS women.

Color doppler ultrasound shows renal vascular resistance using RI value, which corresponds to peak systolic velocity minus end-diastolic velocity divided by peak systolic velocity. The RI values are calculated in the segmental, interlobar, and arcuate arteries, these values are normally below 0.70 except significantly higher in elderly persons and in those younger than 6 years [24]. The effects of variation in vessel angulation and size are nullified in the calculation of these indexes [25]. Various abnormal waveforms may be compared by calculating the RI and PI. Physiologic events that alter vascular resistance and thus affect waveforms include exercise, changes in gravity orientation and stress level, and digestion [25].

Changes in the intrarenal arterial RI values are associated with diseases as urinary obstruction, various renal disorders, renal vascular disease, renal scarring . The RI provides information about arterial impedance. The pressure differential between the systole and diastole was shown to be a major factor influencing RI, along with the vascular compliance and the cross-sectional area of the downstream vascular bed [26].

In our study, there was no difference between RI values of right and left renal arteries (respectivelly 0,636; 0,629 : p>,05). In women with PCOS, average renal RI was slightly higher than healty women (statistically unsignificant) (p=,062). RI correlated

Table 4. Corelations of renal blood flow parameters with biochemical and clinic characteristics in all patients.

		Mean Renal Length	Mean Parenchyma Thickness	Mean Renal Artery PSV	Mean Renal Artery RI	Mean Upper Lobar Renal Artery RI	Mean Middle Lobar Renal Artery RI	Mean Bottom Lobar Renal Artery RI	Mean Venous Impedance Index
BMI	r	,365(**)	,378(**)	-,063	,150	,185	,104	,075	,053
	p	,001	,001	,589	,197	,110	,372	,521	,651
WHR	r	,292(*)	,047	,029	-,149	-,293(*)	-,341(**)	-,127	-,035
	p	,010	,687	,803	,198	,010	,003	,275	,762
Fasting Glucose (mg/dl)	r	,316(**)	,281(*)	,032	-,054	-,053	,021	,267(*)	,022
	p	,005	,014	,784	,641	,646	,857	,020	,850
Insulin (µU/ml)	r	,214	,239(*)	-,375(**)	,508(**)	,252(*)	,278(*)	,304(**)	,139
	p	,063	,037	,001	,000	,028	,015	,008	,231
HOMA index	r	,269(*)	,282(*)	-,355(**)	,475(**)	,230(*)	,251(*)	,325(**)	,149
	p	,019	,014	,002	,000	,046	,029	,004	,200
HDL (mg/dl)	r	-,079	-,015	,053	-,290(*)	-,298(**)	-,168	-,090	-,033
	p	,498	,897	,650	,011	,009	,147	,440	,777
LDL (mg/dl)	r	,483(**)	,012	,094	,113	,154	,113	,264(*)	-,037
	p	,000	,920	,420	,330	,183	,332	,021	,752
Triglycerides (mg/dl)	r	,170	,191	,087	-,057	,066	,128	,147	-,179
	p	,141	,098	,453	,622	,569	,270	,206	,122
Mean Renal Length	r		,477(**)	,179	,087	,035	,178	,279(*)	,059
	p		,000	,121	,455	,767	,125	,015	,610
Mean Parenchyma Thickness	r		1	,111	-,024	,069	,200	,068	-,064
	p			,341	,834	,554	,083	,560	,581
Mean Renal Artery PSV	r			1	-,400(**)	-,047	-,108	-,141	-,502(**)
	p				,000	,690	,353	,225	,000
Mean Renal Artery RI	r				1	,518(**)	,396(**)	,349(**)	,200
	p					,000	,000	,002	,084
Mean Upper Lobar Renal Artery RI	r					1	,612(**)	,439(**)	,034
	p						,000	,000	,772
Mean Middle Lobar Renal Artery RI	r						1	,674(**)	,148
	p							,000	,201
Mean Bottom Lobar Renal Artery RI	r							1	,237(*)
	p								,039

Legend: RI: Resistive index, HOMA index, homeostasis model assessment index: HDL: High-density lipoprotein, LDL: Low-density lipoprotein.

significantly and positively with insulin and HOMA, negatively HDL (Table 4). Mean RI of upper, middle, bottom lobar renal arteries were not difference between two groups. We thought that higher RI values in women with PCOS might be indicate early period of atherosclerosis . Especially, relationship between RI and insulin values may be important to determine mild vascular changes.

The average flow velocity (Vmean) values of renal vein are given in the literature as 10-20 cm/ s. The flow in the renal veins is generally continuous, but mild fluctuations may be seen as a reflection of respiration and right atrial contraction [27].

The flow pattern in intrarenal veins depends on renal parenchymal histology and cardiac physiology. The intrarenal venous impedance index obtained by Doppler ultrasound is related to compliance in vein, and can be helpful in the assessment of renal parenchymal compliance.

renal hemodynamics. Microalbuminuria and reduced glomerular filtration rate (GFR) are two different aspects of renal dysfunction. It is known that renal hemodynamics associated with microalbuminuria and reduced GFR [6]. We did not investigated to linked with renal hemodynamics and renal biometry in this study.

Potential limitations of our study should be noted. First, the cross-sectional study design makes it difficult to infer causality between the PCOS and risk for chronic kidney disease. Second, study population were heterogen in terms of age, BMI (both obes and lean), having insulin resistance. If it is created a patient subgroup with obesity and insulin resistance patient, It could obtain whether causes of hemodynamic alterations are PCOS or insülin resistance. It was suggested by Chen that the metabolic syndrome and insulin resistance might be an important factor in the cause of chronic kidney disease and microalbuminuria [18].

Third, in our study, it is indeterminate patient to what extent period with PCOS. As renal and vascular effect consist during long term period, our findings may be weak than expected really. Fourth, the disadvantages of renal doppler ultrasound include decreased reliability in a patient who is not fasting and/ or is obese, a high level of operator dependence, and poor detail resolution. But, renal doppler ultrasound examination was done by one radiologist for decrease of these disadvantages. Another limitation of our study is that we did not investigate the waveform in the inferior vena cava which might likely be altered and affect the intrarenal venous waveform.

In conclude, we suggested that there was alterations especially kidney blood flow in normotensive reproductive age women with PCOS. This findings may explain to results of long term renal and vascular complications of PCOS. However, a further study with a wider selected subgroups is required.

Competing interests

The authors declare that they have no competing interests.

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