ORIGINAL ARTICLE

ASSESSMENT OF OVARIAN ARTERY DOPPLER INDICES IN WOMEN WITH POLYCYSTIC OVARIAN SYNDROME

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ABSTRACT

OBJECTIVES: The aim of the study is to determine the prevalence of deranged ovarian artery Doppler indices RI and PI in women s concerning for polycystic ovarian syndrome. **STUDY DESIGN:** Descriptive, cross-sectional study. **SETTINGS:** Armed Force Institute of Radiology and Imaging Rawalpindi from 30th December 2020 to 29th June 2021. **METHODOLOGY:** A total of 134 women with polycystic ovarian syndrome as per-operational definition of duration >3 months with age range between 18 to 40 and mean age of 28.87 – 4.81 years of age were included. Patients with hypothyroidism and increased prolactin levels were excluded. All patients were then undergone trans-abdominal USG to localize the anatomical location of ovarian arteries in the region of ovarian hilum bilaterally. Pulsed Doppler range gate was set across vessel and average of three waveforms was obtained. Ovarian Doppler artery indices mainly including values of PI (Pulsatility index =S-D/mean)) and RI (Resistive index=S-D/S) were computed. The value of deranged ovarian artery Doppler indices was recorded. **RESULTS:** Patients between age ranges from 18 to 40 years with mean age of 28.87 – 4.81 years were included. Majority of the patients being n=71 (52.99%) were between 18 to 30 years of age group. Mean time duration of PCOS complains was around 3.64 – 1.59 years. Mean BMI of the patients was 28.95 – 2.41 kg/m^2. Frequency of deranged ovarian artery Doppler indices in women with polycystic ovarian syndrome was found in 94 (70.15%) patients. **CONCLUSION:** This study concluded that prevalence of deranged ovarian artery Doppler indices RI and PI in women with polycystic ovarian syndrome (POCS) is quite high.

Keywords: Polycystic ovarian syndrome, deranged, ovarian artery colour Doppler indices.

Introduction

Patients who suffers from infertility have high prevalence of signs and symptoms along with abnormal hormonal levels that can be classified in the spectrum of polycystic ovarian syndrome.[1] Even though the exact underlying cause of polycystic ovarian syndrome is elusive, it is well established fact that several hormonal disturbances, including increased androgen levels, insulin resistance (IR) such as in diabetic patients and raised insulin levels.[2] Hypothalamus-hypophysis-ovary axis is disrupted by insulin. Insulin resistance by ovarian parenchyma results in defective normal metabolic signalling with maintained mitogenic and steroidogenic activity which results in increased androgen levels which is the main hormone to produce symptoms in patients with PCOS e.g increased facial hair growth e.t.c.[3] Polycystic ovarian syndrome (PCOS) is one of the leading endocrinological problem in women of reproductive age group affecting about 1 out of every 10 women. About 20 to 30 percent of women within their reproductive age group show radiological sign concerning for polycystic ovaries on ultrasound scan.[4] The three primary reasons for

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referral of these patients to radiology department are inability to conceive (74%), menstrual abnormalities e.g prolonged cycles (66%) and an increase in the level of androgens levels leading to abnormal facial hair growth (48%).[5] It has been defined that lack of ability to conceive naturally was one of the leading complaints associated with PCOS. Research have shown evidence to suggest that PCOS is the known to be leading cause of ovarian dysfunction, which in turn is associated with an increased frequency of inability to conceive.[6] Polycystic ovaries are primarily often diagnosed through hormonal testing. The main screening tests include determinations of gonadal hormones including FSH and LH (follicle stimulating hormone and luteinizing hormone), thyroid-stimulating hormone (TSH), and prolactin (PL) blood serum levels. The ratio of FSH to the LH level is most helpful in the evaluation of patients diagnosed with PCOS. TSH or PL levels are recommended in diagnosing other pathological causes, such as hyperthyroidism or prolactinoma which also be related to infertility/ sub-fertility. Furthermore in some patients other laboratory test which could be preformed includes male hormones including testosterone and dihydroepiandrosterone sulfate (DHEAS) levels or a progesterone challenge.[7]

Predominantly, radiologic assessment for polycystic ovaries is done for patients who have normal levels of laboratory evaluation results. Radiologist's guidance can be requested in making diagnosis of polycystic ovarian syndrome for patients. The modality of choice is trans-abdominal and/or trans-vaginal ultrasonography which is easily available, convenient and economical. Magnetic resonance imaging (MRI) is considered as higher modality to get useful as an additional detail; even though MRI has higher sensitivity than ultrasonography in detecting polycystic ovaries, however findings are considered less specific. In recent studies, the benefits of combination of cross-sectional imaging such MRI and functional neuroimaging have been considered and practiced.[8] Determination of anti-Mullerian hormone levels may give new pathway for assessment of the presence of PCOS.[7] Polycystic ovarian syndrome is a combination of clinical and laboratory findings and not just a primary disease. When the diagnosis of polycystic ovaries is considered at radiologic examination, needs to be further assessed with diagnostic tests to determine the underlying aetiology. The assessment of ovarian pathology with ultrasound is considered to be crucial in the diagnosis of PCOS and is also considered as gold standard for defining PCO.[9] Sonography has given much new information regarding the morphological and pathophysiological details regarding blood flow dynamics within the female pelvis.[10,11] Recent studies have shown that many important changes occur within the blood flow and vascularization of ovaries at the level of ovarian arteries.[11,12] In a study conducted by Khan A in year 2019 showed that ovarian artery Doppler indices were abnormal in 85.4% women who presented with clinical and laboratory abnormalities diagnosed with PCOS.[13] Main rationale of this study was to evaluate a non-invasive approachable, economical, readily available and time efficient modality of Doppler ultrasound and its utmost importance in diagnosis of polycystic ovaries. I wished to determine the accurately diagnosed cases of PCOS using ultrasound Doppler of ovarian artery PI and RI as if found acceptable then this can be used routinely in our practice.

Methodology

The study was conducted at Armed Forces Institute of Radiology and Imaging, Rawalpindi from 30th December 2020 to 29th June 2021. After approval from institutional ethical review committee (IERB approval certificate no. 0031). Sample size was calculated by using open epi calculator (https://www.openepi.com/SampleSize/SSPropor.htm) and having 95% confidence level, 6% margin of error and incidence of deranged ovarian artery Doppler indices in women with polycystic ovarian syndrome as 85.4%.[13] 134 patients with mean age of 28.87 – 4.81 years (18 to 40 years) presenting to Armed Forces Institute of Radiology And Imaging, Rawalpindi, fulfilling the inclusion criteria were included in the study by non-probability and consecutive sampling. Patients were briefed about the procedure and study details after which they were asked to sign the consent form before being included in the study.

a. Inclusion Criteria:

All women with polycystic ovarian syndrome as per-operational definition of duration >3 months.

Age 18-40 years.
Both married and unmarried.

b. Exclusion Criteria:

Patients diagnosed with hypothyroidism (TSH >5.2 mIU/L and FT3 <1.5 pg/ml, FT4 <0.8 pg/ml, T3 <70 ng/dl, T4 <5.2 g/dl).

Hyperprolactinemia i.e. prolactin levels >500 mIU/L.

Women receiving oral contraceptive pills.

Patients (n=134) who had fulling the inclusion criteria were enrolled in the study after obtaining well informed written consent. All patients were than assessed by ultrasound to localize the ovarian arteries in the region of hilum of ovaries. The gate of Pulsed Doppler range was than set across vessel lumen to acquire an average of three waveforms. Ovarian Doppler artery indices including Pulsatility index (PI=S-D/mean) and Resistive index (RI=S-D/S) were analyzed. Pulsatility and Resistive indices of ovarian artery were labelled deranged if above or below the normal range of PI (range: 2.01to 4.30) and RI (range: 0.80 to 0.95). Deranged ovarian artery Doppler indices were noted. This all data (age, duration of PCOS, BMI, place of living (rural/urban), pulsatility index, resistive index and deranged ovarian artery Doppler indices (yes/no)) was documented on Performa. Data was statistical analysed using SPSS version 25.0. Mean and standard deviation were calculated for age, BMI, duration of PCOS, pulsatility index and resistive index. Place of living (rural/urban), marital status (unmarried/married) and deranged ovarian artery Doppler indices (yes/no) were presented as frequency and percentage.

Effect modifiers like age, body mass index, marital status (unmarried/married), and duration of PCOS and place of living (rural/urban) were controlled through stratification and post-stratification chi square test was applied to see their effect on deranged ovarian artery Doppler indices. P-value = 0.05 was considered as significant.

Results

Age range in this study was from 18 to 40 years with mean age of 28.87 – 4.81 years. Majority of the patients 71 (52.99%) were between 18 to 30 years of age. Mean duration of PCOS was 3.64 – 1.59 years. Mean BMI was 28.95 – 2.41 kg/m^2 (Tab.1). Distribution of patients according to marital status (Fig.1) showed 90 (n= 70.9%) were married and 39 (29.10%) were unmarried. Distribution of patients according to place of living showed that 55 patients (41.04%) lived in rural areas and 79 patients (58.96%) lived in urban areas. Frequency of abnormal ovarian artery Doppler indices in women with polycystic ovarian syndrome was found in 94 (70.15%) patients as shown in (Fig.2). Stratification of deranged ovarian artery Doppler indices with respect to age of patient (P- value= 0.941) showed that between age range of 18 to 30, there was predominance of derange indices seen in 50 patients with 21 patients showed normal Doppler artery indices. In age rages from 31 to 40 years 44 patients showed deranged artery

BMI (kg/m2)	No. of Patients	%age
≤30	91	67.91
>30	43	32.09
Total	134	100.0

Mean – SD = 28.95 – 2.41 kg/m^2

Table 1: Distribution of patients according to BMI (n=134).

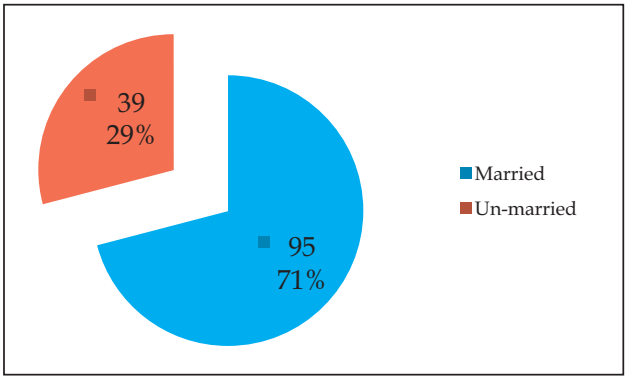

Figure 1: Distribution of patients according to marital status (n=134).

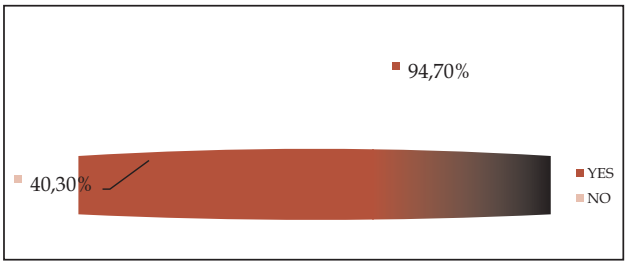

Figure 2: Frequency of deranged ovarian artery Doppler indices in women with Polycystic ovarian syndrome (n=134).

of symptoms of PCOS 48 patients showed deranged artery indices while only 22 patients showed normal Doppler artery indices. Stratification of deranged ovarian artery Doppler indices with respect to BMI (P-value= 0.037) (Tab.2) showed that in case of BMI less than 30 Kg/m^2 showed deranged indices in 69 patients while 20 patients showed normal Doppler artery indices. In case of BMI more than 30 Kg/m^2, 25 patients showed deranged artery indices while only 18 patients showed normal Doppler artery indices. Stratification of deranged ovarian artery Doppler indices with respect to Marital status (P-value= 0.882) showed deranged indices in 27 patients, who were married 12 patients showed normal Doppler artery indices. In case patients who were unmarried, 67 patients showed deranged artery indices while only 28 patients showed normal Doppler artery indices. Stratification of deranged ovarian artery Doppler indices with respect to place of living (P-value =0.823) showed deranged indices in 38 patients, who lived in rural area while 17 patients showed normal Doppler artery indices. In case patients living in urban areas, 56 patients showed deranged artery indices while only 23 patients showed normal Doppler artery indices is shown (Tab.3).

BMI (kg/m^2)	Deranged ovarian artery Doppler indices		p-value
	Yes	No	
≤30	69	22	0.037
>30	25	18	

Table 2: Stratification of deranged ovarian artery Doppler indices with respect to BMI.

Place of living	Deranged ovarian artery Doppler indices		p-value
	Yes	No	
Rural	38	17	0.823
Urban	56	23	

Table 3: Stratification of deranged ovarian artery Doppler indices with respect to place of living.

Discussion

Ultrasound evaluation of ovarian abnormalities is known to be utmost important in the diagnosis of patients with PCOS and known to be criterion standard for definition of polycystic ovary (PCO).[14] The polycystic ovary is the structural ovarian phenotype in women who developed abnormal FSH to LH ratio and clinical complains of polycystic ovary syndrome. However it is not necessary that all women diagnosed with polycystic ovaries will demonstrate ever single clinical and biochemical features that would categorized them in the category of patients suffering from polycystic ovarian syndrome. The commencement of TVS (trans-vaginal Doppler sonography) for pelvic examination has given a tremendus contribution in correct ultrasound diagnosis. Furthermore it has provided knowledge regarding much new aspects regarding anatomical and pathophysiological details on blood flow mechanism within the female pelvis. It has revealed that in patients who presented with polycystic ovarian syndrome demonstrates important modifications/alterations in ovarian vascularization occur at the level of the ovarian arteries within the region of ovarian hilum. Two-[14] or three-dimensional[15] ultrasonography has confirmed these hypotheses with help of colour Doppler systems analysis.

I have conducted this study to know about the prevalence of abnormal range of ovarian artery Doppler indices in women who are labelled with polycystic ovarian syndrome. In my study, frequency of abnormal ovarian artery Doppler indices was demonstrated in women with polycystic ovarian syndrome in 94 (70.15%) patients. In a study, done by Khan A in year 2019 showed that ovarian artery Doppler indices including RI and PI were abnormal in 85.4% women with PCOS.[13] A study on PCOS: Assessment with colour Doppler angiography and three dimensional ultrasonography presume that uterine artery Doppler indices including both pulsatility index (PI) and resistive index (RI) are above 95th percentile in patients with PCOS.[16] Study conducted by Mala YM in 2009 Polycystic ovary syndrome: relationship between insulin sensitivity, sex hormone levels and ovarian stromal blood flows culminated that mean uterine artery PI and RI were both below 50th percentile in women diagnosed with PCO.[17]

Multiple studies conducted on measurements on blood flow with uterine and ovarian arteries have showed elevated resistance index above 95th percentile having correlation with deranged hormonal assay. One of these studies had showed a strong association between serum LH: FSH ratio and artery pulsatility index (PI) of ovaries.[18]

Zaidi et al 1995[20] conducted study within the intra-

ovarian artery vasculature which demonstrates raised intensity of colour flow on colour Doppler index in the ovarian parenchyma of patients with PCOS. The impedance in the blood flow of the ovarian artery was significantly lower in women with PCOS, i.e. the ovarian RI was appreciably lower in PCOS group (0.52 – 0.09 in cases and 0.71 – 0.08 in controls)[20] as previously reported by Mohammed et al. 2003 (0.55– 0.16),[21] Bostanci et al. 2013[22] (ovarian RI 0.56 – 0.05) and Aleem and Predanic 1996 (ovarian RI 0.55 – 0.01 in cases and 0.78 – 0.06 in controls).[23] In a study, the PI of the ovarian stromal artery was notably lower (1.15 – 0.45 in case and 4.2 – 0.78 in control),[20] i.e., blood flow in ovarian stromal artery was raised in patients with PCOS in comparison with the control group as documented by Adali et al. 2009 (Ovarian PI, 1.40 – 0.63 in cases and 2.90 – 0.20 in controls) and Dhingra 201724 (0.96 + 0.19 in cases and 2.6 + 0.26 in controls). In comparison done between PCOS and PCO only group showed that uterine artery PI was above 95th percentile in PCOS group. Strong correlations have been seen in PCOS group as previously documemted[25] with raised uterine artery PI and abnormal DHEAS and AS level.

PCOS patients have an increased tendency to atherosclerosis which results in stiffness and thickening of vessel walls causing increased systemic vascular resistance. Crucial long term risk factor to be considered in patient with PCOS is possibility of myocardial infarction and coronary artery disease. These limited available research in the literature concerning the uses of Doppler ultrasound parameters in women with PCO only and PCOS, which is crucial in the interpretation of the main mechanism of PCOS.

Conclusion

This study concluded that prevalence of deranged ovarian artery Doppler indices in women with polycystic ovarian syndrome is quite high. So, we recommend that deranged ovarian artery Doppler indices should be used for early and timely diagnosis of polycystic ovarian syndrome for taking proper lifestyle changes or pharmacological treatment in order to reduce the morbidity.

Conflict of Interest: Declared none by authors.

References

1. Sangabathula H, Varaganti N. Clinical profile polycystic ovarian syndrome - 100 cases. Int J Contemporary Med Res. 2017; **4(6):** 1249-53.

2. Rojas J, ChÆvez M, Olivar L, Rojas M, Morillo J, Mej as J, et al. Polycystic ovary syndrome, insulin resistance, and obesity: navigating the pathophysiologic labyrinth. Int J Reprod Med. 2014; **2014:** 719050.

3. Fauser BC, Tarlatzis BC, Rebar RW. Consensus on women s health aspects of polycystic ovary syndrome (PCOS): the Amsterdam ESHRE/ASRM-Sponsored 3rd PCOS Consensus Workshop Group. FertilSteril. 2012; **97:** 28-38.

4. Younesi L, Lima ZS, Sene AA, Jebelli ZH, Amjad G. Comparison of uterine and ovarian stromal blood flow in patients with polycystic ovarian syndrome. Endocr Connect. 2019; **8(1):** 50-6.

5. Rosenfield RL, Ehrmann DA. The pathogenesis of polycystic ovary syndrome (PCOS): the hypothesis of PCOS as functional ovarian hyperandrogenism revisited. Endocr Rev 2016; **37(5):** 467-520.

6. Gupta V, Sharma S, Raina SK, Bedi GK. Clinical and biochemical correlates of PCOS: a casecontrol study from a tertiary care center in North India. J Sci Soc. 2018; **45(1):** 332-6.

7. Simic D, Stefanovic K, Djuric D, Turnic TN. Polycystic Ovary Syndrome: Pathophysiology, Presentation and Treatment a Mini-Review Article. Serbian J ExpClinRes. March 2021; 0(0).

8. Lalwani N, Patel S, Ha KY, Shanbhogue AK, Nagar AM, Chintapalli KN, et al. Miscellaneous tumour-like lesions of the ovary: cross-sectional imaging review. Br J Radiol. May 2012; **85(1013):** 477-86.

9. Fetouh AA, Mohamed RS. Ovarian doppler study

in polycystic ovary syndrome in relation to body weight. Al-Azhar Assiut Med J. 2015; **13(3):** 34-42.

10. Bano A, Tariq A, Rehman AU. Diagnosis of PCOS on doppler based resistive and pulsatility index. J Rawal Med Coll 2016; **20(4):** 305-8

11. Dwivedi S, Ujjaliya MK, Kaushik A. Assessment of the best predictor for diagnosis of polycystic ovarian disease in colordoppler study of ovarian artery. Int J Sci Stud 2019; **6(12):** 154-62.

12. Dhingra D, Prateek S, Sinha R, AgarwalY, Doppler flow velocities of uterine and ovarian arteries and hormonal patterns in patients with polycystic ovary syndrome (PCOS). Int J Healthc Biomed Res 2017; **5:** 48-57.

13. Khan A, Qasmi IM, Mirza TM, Kubra KT. Frequency of ovarian artery doppler indices in patients of polycystic ovarian syndrome. Pak J Radiol. 2019; **29(4):** 218-21.

14. Gyliene A, Straksyte V, Zaboriene I. Value of ultrasonography parameters in diagnosing polycystic ovary syndrome. 2022; **17(1):** 1114-22.

15. Pan HA, Wu MH, Cheng YC, Li CH, Chang FM. Quantification of Doppler signal in polycystic ovary syndromeusing three-dimensional power Doppler ultrasonography:a possible new marker for diagnosis. Hum Reprod 2002; **17:** 2011-16.

16. Bano A, Tariq A. Diagnosis of Polycystic Ovarian Syndrome on Doppler Based Resistive Index and Pulsatility Index. (JRMC); 2016; **20(4):** 305-8.

17. Mala YM, Ghosh SB, Tripathi R. Three-dimensional power Doppler imaging in the diagnosis of polycystic ovary syndrome Int .J GynaecolObstet, 2009; **105:** 36-8.

18. Sheng C, Zhang J, Jue J. The Relationship between Ovarian Ultrasound Parameters and Endocrine and Metabolic Indicators in Patients with Ovarian Syndrome. Evid Based Complement Alternat Med. Jul 2022; **2022:** 7238344.

19. Balen AH, Laven JSE, Tan SL, Dewailly D. Ultrasound assessment of the polycystic ovary: international consensus definitions. Human Reproduction Update. 2003; 9505-14.

20. Dwivedi, A.N.D., V. Ganesh, R.C. Shukla, M. Jain, and I. Kumar. Colour Doppler Evaluation of Uterine and Ovarian Blood Flow in Patients of Polycystic Ovarian Disease and Post-Treatment Changes. ClinRadiol Oct 2020; **75(10):** 772-9.

21. Dwivedi S, Ujjaliya MK, Kaushik A. Assessment of the Best Predictor for Diagnosis of Polycystic Ovarian Disease in Color Doppler Study of Ovarian Artery. Int J Sci Stud 2019; **6(12):** 154-62.

22. Mohamed A, Ebrahim H. Doppler Study of Uterine and OvarianmVasculature During different Phases of the Menstrual Cycle in Polycystic Ovarian Disease, Faculty of Medicine. Cairo: Cairo University; 2012.

23. Bostanci MS, Sagsoz N, Noyan V, Yucel A, Goren K. Comprasion of ovarian stromal and uterin artery blood flow measured by Color Doppler ultrasonography in polycystic ovary syndrome patients and patients with ultrasonographic evidence of polycystic. J Clin Gynecol Obstet 2013; **2:** 20-6.

24. Battaglia C, Battaglia B, Morotti E, Paradisi R, Zanetti I, Meriggiola MC, Venturoli S. Two and three-dimensional sonographic and colordoppler techniques for diagnosis of polycystic ovary syndrome: The stromal/ ovarian volume ratio as a new diagnostic criterion. Journal of Ultrasound in Medicine 2012; **31:** 1015-24.

25. Dhingra D, Prateek S, Sinha R,AgarwalY, Doppler flow velocities of uterine and ovarian arteries and hormonalpatterns in patients with polycystic ovary syndrome (PCOS). Int J Healthc Biomed Res 2017; **5:** 48-57.

26. Adali E, Kolusari A, Adali F, Yildizhan R, Kurdoglu M, Sahin HG. Doppler analysis of uterine perfusion and ovarian stromal blood flow in polycystic ovary syndrome. Int J Gynaecol Obstet. 2009; **105(2):** 154-7.