

Correlation Between MRI-Based Radiological Features of Female Reproductive Organs and Blood Hormone Levels in Patients with PCOS: A Comprehensive Study

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Abstract

Background: Women who are of reproductive age are frequently affected by PCOS, or polycystic ovarian syndrome, an endocrine condition. Clinical and biochemical factors, such as hormone abnormalities and polycystic ovarian morphology on ultrasound, are used to diagnose PCOS. Because magnetic resonance imaging (MRI) may provide extensive anatomical information on the ovaries and other pelvic tissues, it has become a viable imaging tool for the evaluation of PCOS.

Goal: Using MRI, examine the relationship between blood hormone levels and radiological characteristics of the female reproductive organs in patients complaining of PCOS.

Techniques: A total of 150 patients with PCOS diagnoses were drawn from departments of gynecology and endocrinology. Every patient had a pelvic MRI as well as a hormonal evaluation that included follicle-stimulating hormone (FSH), luteinizing hormone (LH), and androstenedione tests. Two skilled radiologists who were blinded to the clinical and hormonal information assessed the MRI scans. Ovarian volume, shape, the existence of ovarian cysts, the number and size of ovarian follicles, and stromal hyperplasia were among the radiological features evaluated. A statistical analysis was conducted to ascertain the relationship between blood hormone levels and radiographic findings.

Results: The most often seen radiological abnormalities in the research population were ovarian cysts, many tiny follicles, enlarged ovaries, and stromal hyperplasia. Radiological characteristics and levels of testosterone ($r=0.65-0.72$, $p<0.001$), LH ($r=0.72-0.78$, $p<0.001$), and FSH ($r=0.60-0.70$, $p<0.001$) were found to have significant positive relationships.

Conclusion: In conclusion, this study shows that blood hormone levels in individuals with PCOS complaints are significantly correlated with radiographic characteristics of the female reproductive organs. With its ability to provide detailed anatomical information and facilitate comprehension of the underlying hormonal abnormalities, MRI exhibits promise as an additional diagnostic technique in the diagnosis of PCOS.

Keywords: luteinizing hormone, follicle-stimulating hormone, blood hormone levels, MRI, radiological features, polycystic ovary syndrome, androgen hormones.

Introduction

Approximately 5–10% of women who are of reproductive age suffer with Polycystic Ovary Syndrome (PCOS), which is one of the most common endocrine illnesses in this population [1]. Menstrual abnormalities, hyperandrogenism, and polycystic ovaries are among the symptoms that define the syndrome; these conditions frequently show up clinically as hirsutism, acne, and infertility [2]. The variety of PCOS's clinical presentation and diagnostic difficulties are a result of the disease's multifaceted etiology, which includes genetic, environmental, and metabolic variables [3].

Traditionally, the Rotterdam criteria have been used to diagnose PCOS. These criteria require the presence of two out of the following three features: polycystic ovaries on ultrasound examination, clinical and/or biochemical evidence of hyperandrogenism, and oligo- or anovulation [4]. Although ultrasonography is still a commonly utilized imaging modality in the assessment of PCOS, it does not provide a clear anatomical picture of the female reproductive organs, only morphological information [5].

Due to its capacity to produce rich anatomical information about the ovaries and other pelvic tissues as well as high-resolution images, Magnetic Resonance Imaging (MRI) has become a potential imaging modality in the assessment of PCOS in recent years [6]. PCOS diagnosis accuracy may be improved by using MRI to more precisely and clearly show the ovarian stroma, follicles, and other associated abnormalities [7].

Furthermore, luteinizing hormone (LH), follicle-stimulating hormone (FSH), and high levels of androgen hormones are examples of hormonal abnormalities that are critical to the pathophysiology of PCOS [8]. Previous research has shown a relationship between particular radiological characteristics and hormone abnormalities, indicating that MRI may be used to assess hormonal state indirectly by looking at morphological changes in the female reproductive organs [9-12].

There is a dearth of research examining the direct relationship between blood hormone levels and radiological characteristics of female reproductive organs, despite the potential benefits of MRI in the assessment of PCOS. In order to close this knowledge gap, this study will investigate the connection between MRI results and hormonal abnormalities in patients who have complained of PCOS. This research may offer important new perspectives on the use of MRI as a supplemental diagnostic tool in PCOS.

Material and methods

Study population: Between 2021 and 2022, 150 patients with Polycystic Ovary Syndrome (PCOS) were selected from the tertiary care center's endocrinology and gynecology departments. Women who satisfied the Rotterdam criteria for a PCOS diagnosis and were between the ages of 18 and 35 were eligible for inclusion. Pregnancy, prior ovarian surgery, and other endocrine conditions such as Cushing's disease, congenital adrenal hyperplasia, and androgen-secreting tumors were among the exclusion criteria.

Radiological Evaluation

A 1.5-Tesla magnetic resonance imaging (MRI) scanner was used for pelvic MRI exams on all patients (GE Healthcare, USA). Included in the MRI protocol were the following steps:

1. T1-weighted radiography
2. T2-weighted radiography
3. Suppressed fat T2-weighted imaging
4. Imagery that is diffusion-weighted (DWI)

Two skilled radiologists who were blinded to the clinical and hormonal information assessed the MRI scans. Among the radiological features evaluated were:

1. Ovarian morphology and volume
2. Ovarian cyst presence
3. Ovarian follicle count and size
4. Stromal hyperplasia is present

Evaluation of Hormones

Following an overnight fast, venous blood samples were taken from each patient during the early follicular phase (days 2–5) of the menstrual cycle. After centrifuging the blood samples, the serum was kept cold—at -80°C —pending examination. The enzyme-linked immunosorbent test (ELISA) was used to measure the following amounts of hormones:

1. The hormone testosterone
2. Androstenedione
3. Hormone luteinizing (LH)
4. FSH, or follicle-stimulating hormone

Analytical Statistics

The SPSS program (version 25.0, IBM Corp., Armonk, NY, USA) was used to analyze the data. The study population's clinical and demographic features were compiled using descriptive statistics. The Shapiro-Wilk test was used to determine whether the distribution of the data was normal. The relationship between blood hormone levels and radiographic characteristics was examined using Pearson's correlation coefficient. P-values less than 0.05 were regarded as statistically significant.

Ethical aspects

The Institutional Ethics Committee gave its approval and the research was carried out in compliance with the Declaration of Helsinki. Prior to their registration in the trial, all individuals provided written informed consent.

Results

Table 1 provides an overview of the research population's clinical and demographic characteristics. The participants' mean BMI was $28.1 \text{ kg/m}^2 (\pm 3.5)$ and their mean age was 28.4 years (± 4.2). The menstrual cycle lasted an average of 35.7 days (± 7.2) and the duration of PCOS was 5.2 years (± 2.3). According to the Ferriman-Gallwey approach, the average hirsutism score was $15.2 (\pm 4.5)$.

The radiographic characteristics seen in PCOS patients are shown in Table 2. In 90% of the patients, enlarged ovaries were seen, and in

96.7% of the cases, many tiny follicles were found. Eighty percent of the patients had ovarian cysts detected, and seventy-three percent of the cases had stromal hyperplasia. Adnexal masses were present in a smaller subset of individuals (16.7%).

Table 3 provides specific information about the study participants' hormone characteristics. The average concentrations of androstenedione and testosterone were 2.50 ng/mL and 0.95 ng/mL , respectively. Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) had mean values of 8.0 mIU/mL and 12.5 mIU/mL , respectively. There was 40.0 pg/mL of mean estradiol present.

The relationship between testosterone levels and radiological characteristics is shown in Table 4. Testosterone levels were shown to be significantly positively correlated with larger ovaries ($r=0.65$, $p<0.001$), many tiny follicles ($r=0.72$, $p<0.001$), and ovarian cysts ($r=0.50$, $p<0.002$). Furthermore, there was a somewhat favorable connection ($r=0.45$, $p=0.005$) between stromal hyperplasia and testosterone levels.

The relationship between radiological characteristics and LH levels is shown in Table 5. There was a substantial positive association seen between LH levels and ovarian cysts ($r=0.55$, $p<0.001$), many tiny follicles ($r=0.78$, $p<0.001$), and enlarged ovaries ($r=0.72$, $p<0.001$). There was also a moderate positive connection ($r=0.48$, $p=0.003$) between LH levels and stromal hyperplasia.

Finally, the relationship between radiographic characteristics and FSH levels is shown in Table 6. Significant positive correlations were seen between FSH levels and ovarian cysts ($r=0.48$, $p=0.003$), many tiny follicles ($r=0.70$, $p<0.001$), and enlarged ovaries ($r=0.60$, $p<0.001$). Additionally, a somewhat favorable connection ($r=0.42$, $p=0.007$) was found between FSH levels and stromal hyperplasia.

Discussion

The complicated endocrine condition known as Polycystic Ovary Syndrome (PCOS) is typified

by polycystic ovarian morphology, chronic anovulation, and hyperandrogenism [1]. PCOS's etiology and pathophysiology are still complex, resulting from a combination of hereditary and environmental variables [2]. The purpose of this study was to look at the relationship between blood hormone levels and radiographic characteristics of the female reproductive organs in individuals who complained of PCOS.

Our results showed a strong relationship between certain radiological characteristics and high levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), and androgen hormones. In the research population, ovarian cysts, numerous tiny follicles, and enlarged ovaries were the most often seen radiological abnormalities. According to PCOS diagnostic criteria, which stress the existence of polycystic ovarian morphology on ultrasound examination, these results are in line [3].

Notable is the relationship between testosterone levels and radiographic characteristics. The presence of ovarian cysts, numerous tiny follicles, and enlarged ovaries was significantly positively correlated with testosterone levels. This implies that the morphological alterations seen in PCOS patients' ovaries may be caused by an excess of androgen. One of the main characteristics of PCOS is hyperandrogenism, which is also essential to the pathophysiology of the condition [4]. Increased testosterone levels can cause follicular stoppage and the development of many tiny follicles, which can contribute to the distinctive polycystic ovarian shape shown in imaging investigations [5].

Likewise, a noteworthy affirmative connection was identified between radiological characteristics and levels of LH. It is well known that LH causes theca cells in the ovary to produce more androgen, which exacerbates hyperandrogenism in PCOS patients [6]. The higher LH levels in our study may have contributed to the higher number of tiny follicles and ovarian cysts seen. Elevated LH levels stimulate follicular growth but suppress

ovulation, which causes an accumulation of immature follicles in the ovary [7].

It's interesting to note that there was a strong positive link found between FSH levels and the radiological characteristics of PCOS. While FSH plays a major role in follicular development and maturation, increased levels of the hormone in PCOS patients may suggest that the ovaries are relatively insensitive to FSH stimulation, which could result in the recruitment of several tiny follicles without effective ovulation [8].

The results of this investigation are in line with earlier studies that found a correlation between ovarian shape and hormonal abnormalities in PCOS patients [9, 10]. However, by showing a clear link between radiological results and blood hormone levels, our study offers fresh perspectives and emphasizes the potential of MRI as an additional diagnostic tool for PCOS.

When evaluating PCOS, magnetic resonance imaging (MRI) has a number of advantages than standard ultrasound. The ovarian stroma, follicles, and other associated anomalies can all be seen more clearly and with greater anatomical detail thanks to magnetic resonance imaging (MRI) [11]. Furthermore, when it comes to ovarian volume and morphology assessment, MRI can be more reliable and consistent than ultrasound because it is not operator-dependent [12].

Even with the study's encouraging results, there are a few things to keep in mind. Our ability to establish a causal relationship between the hormonal abnormalities reported in PCOS patients and the radiological characteristics is limited by the cross-sectional nature of the study. Furthermore, the study cohort was made up mostly of young women with recently diagnosed PCOS, making it rather homogeneous. Further research involving bigger and more diverse populations is required to corroborate our results and investigate the possible clinical applications of MRI in the diagnosis and treatment of PCOS.

Conclusion

Our research concludes that there is a substantial relationship between blood hormone levels and radiographic characteristics of the female reproductive organs in patients complaining of PCOS. With its ability to provide detailed anatomical information and facilitate comprehension of the underlying hormonal abnormalities, MRI exhibits promise as an additional diagnostic technique in the diagnosis of PCOS. To confirm these results and investigate the possible therapeutic applications of MRI in PCOS diagnosis and treatment, more investigation is necessary.

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Tables

Table 1: Demographic and Clinical Characteristics of the Study Population

Parameter	Mean $\pm$ SD (Range)
Age (years)	28.4 $\pm$ 4.2 (18-35)
BMI (kg/m ²)	28.1 $\pm$ 3.5 (20-35)
Duration of PCOS (years)	5.2 $\pm$ 2.3 (1-10)
Menstrual cycle length (days)	35.7 $\pm$ 7.2 (21-60)
Hirsutism score (Ferriman-Gallwey)	15.2 $\pm$ 4.5 (6-24)

Table 2: Radiological Features of Female Reproductive Organs in PCOS Patients

Radiological Features	Number of Patients (%)
Enlarged Ovaries	135 (90%)
Multiple Small Follicles	145 (96.7%)
Ovarian Cysts	120 (80%)
Stromal Hyperplasia	110 (73.3%)
Adnexal Mass	25 (16.7%)

Table 3: Hormonal Levels in PCOS Patients

Hormones	Mean Level (ng/mL)	Standard Deviation
Testosterone	0.95	0.25
Androstenedione	2.50	0.50
LH	12.5	3.0
FSH	8.0	2.5
Estradiol	40.0	10.0

Table 4: Correlation between Radiological Features and Testosterone Levels

Radiological Features	Testosterone (r)	p-value
Enlarged Ovaries	0.65	<0.001
Multiple Small Follicles	0.72	<0.001
Ovarian Cysts	0.50	0.002
Stromal Hyperplasia	0.45	0.005

Table 5: Correlation between Radiological Features and LH Levels

Radiological Features	LH (r)	p-value
Enlarged Ovaries	0.72	<0.001
Multiple Small Follicles	0.78	<0.001
Ovarian Cysts	0.55	0.001
Stromal Hyperplasia	0.48	0.003

Table 6: Correlation between Radiological Features and FSH Levels

Radiological Features	FSH (r)	p-value
Enlarged Ovaries	0.60	<0.001



Bi-Monthly

**International
Journal of
Medical Research**

**ISSN: 2815-0554
(Online)**

Multiple Small Follicles	0.70	<0.001
Ovarian Cysts	0.48	0.003
Stromal Hyperplasia	0.42	0.007