Original research article

A study on ultrasonographic changes in patients of polycystic ovary syndrome and its correlation with clinical and hormonal profile in a tertiary centre in Guntur

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 Abstract
Background: Polycystic ovary syndrome is the most common endocrine disorder and most common cause of ovarian dysfunction in women of reproductive age group. Clinical manifestations of PCOS range from mild signs of hyperandrogenism to the classic Stein-Leventhal syndrome.
Aims: To correlate between ultrasonographic findings, clinical features, and hormonal profile in patients with polycystic ovary syndrome.
Materials and Methods: The present study was a Cross-sectional study. This study was conducted from January 2021 to February 2023 at the Department of Radiodiagnosis, Katuri Medical College and Hospital, Katuri Nagar, Guntur, Andhra Pradesh, India.
Result: FSH levels were low to normal in 85.3% of the patients with >12 follicles, 86.8% of the patients with 2-9 mm follicular size, 87.3% of the patients with >10cc ovarian volume, and 94% of the patients with EMT>10mm. The mean FSH level is lower in patients with 2-9mm follicles compared to patients with >9mm follicular size.
Conclusion: Thus, this study concludes that ultrasonographic ovarian features like follicular number and ovarian volume show significant positive correlations with LH level as well as positive correlations with LH/FSH ratio.
Keywords: Body mass index, obesity, and polycystic ovarian syndrome

Introduction

Polycystic ovary syndrome is the most common endocrine disorder in women of reproductive age group [1]. Stein and Leventhal initially described it in 1935 in a group of patients presenting with amenorrhoea, bilateral polycystic ovaries and masculinizing changes which might be due to the result of some hormonal stimulation. The prevalence ranges between 5% and 15% depending on the diagnostic criteria applied [2]. It is the most common form of chronic anovulation associated with androgen excess and this complex disorder may be inherited in a polygenic fashion [3]. The exact pathophysiology of PCOS is still a matter of debate [4]. The key features are androgen excess, hypothalamic-pituitary-gonadal axis imbalance, insulin resistance and abnormal gonadotropin dynamics. An increased pulse frequency of GnRH leads to an increased pulse frequency of LH rather than FSH, which in turn results in tonically elevated level of LH. The LH/FSH ratio is increased. Because of low FSH levels, follicular growth is arrested at different phases of maturation (2-10mm). elevated levels of LH stimulate theca cells to produce excess androgens The net effect is diminished estradiol and increased inhibin production and high prolactin level [5, 6].

Women with PCOS present to the healthcare system with 3 major complaints:
1.   Menstrual irregularities (oligomenorrhoea or amenorrhoea).
2.   Hyperandrogenism (hirsutism).
3.   Anovulatory infertility [7].

Besides these, patients have obesity and several long-term health risks such as type 2 diabetes mellitus,

cardiovascular diseases, obstructive sleep apnoea and endometrial cancer.

Ultrasonography is a non-invasive, nonionizing investigation that aids in the proper diagnosis of this syndrome. it defines the ovarian morphology to determine the etiology of anovulation depending on which, various forms of polycystic ovaries are identified. As per Rotterdam criteria (2003 consensus), the ultrasonographic features diagnostic of PCOS are,

▪ Either 12 or more follicles within the entire ovary measuring 2-9mm in diameter.
▪ Increased ovarian volume > 10cc.

Increased stromal echogenicity was not included in the diagnostic criteria as it is subjective [8, 9].

Materials and Methods

Study site: Department of Radiodiagnosis, Katuri Medical College and Hospital, Katuri Nagar, Guntur, Andhra Pradesh, India.

Study design: Cross-sectional study.

Period of study: January 2021 to February 2023.

Sample size: 100 (one hundred) patients.

Inclusion criteria

Patients within the age group of 15- 35yrs, who have been newly diagnosed with polycystic ovarian syndrome according to Androgen excess and PCOS society criteria were included in this study.

Exclusion criteria

Patients with PCOS who are on treatment or follow-up; Patients aged < 15 years or > 35 years and patients with hormonal disorders like 21 hydroxylases deficient non-classic adrenal hyperplasia, androgen-secreting neoplasms, valproate/steroids/androgenic/anabolic drug use or abuse, Cushing's syndrome, the hyperandrogenic insulin resistance acanthosis nigricans syndrome, thyroid dysfunction and hyperprolactinemia were excluded from the study

Result and Discussion

The present study was a Cross-sectional study. This study was conducted from January 2021 to February 2023 at the Department of Radiodiagnosis, Katuri Medical College and Hospital, Katuri Nagar, Guntur, Andhra Pradesh, India.

Patients' Age-Wise Distribution

the mean age of presentation is 22.96 + 4.84 years. The majority (76%) of the patients were in the age range of 15-25 years. Similar results were observed in the studies by Monojit Chakrabarti *et al.* [10] who observed that the maximum prevalence of PCOS was seen between 15 to 24 years of age group.
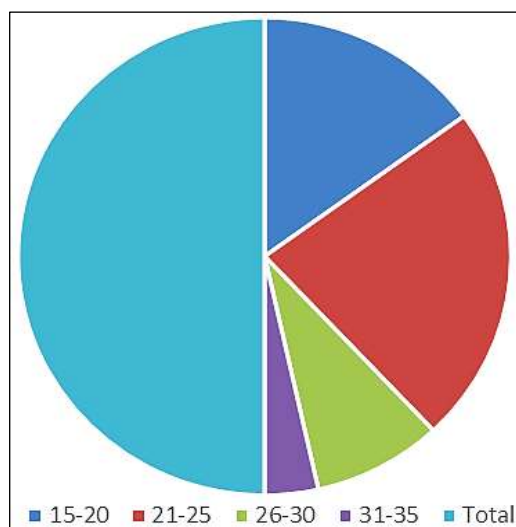

Fig 1: Age distribution

Patient's marital status

Most of the patients were unmarried (68%) compared to married (32%) in the present study This observation is in accordance with the study by Begum *et al.* [11] Who observed in that study, out of 102 patients with clinically suspected polycystic ovary syndrome, most of the patients were unmarried

(81.6%).

Patient's chief complaints
All of the patients (100%) presented with oligomenorrhoea in the present study. Obesity (65%) followed by hirsutism (54%), infertility (24%), and acne (10%) were other chief complaints.
Almost similar observations were found in the study by Nagamani Peri *et al*. [12] with 245 patients of polycystic ovarian syndrome where 146 patients showed menstrual irregularities. It was followed by 38 patients with hirsutism and 15 patients with infertility.
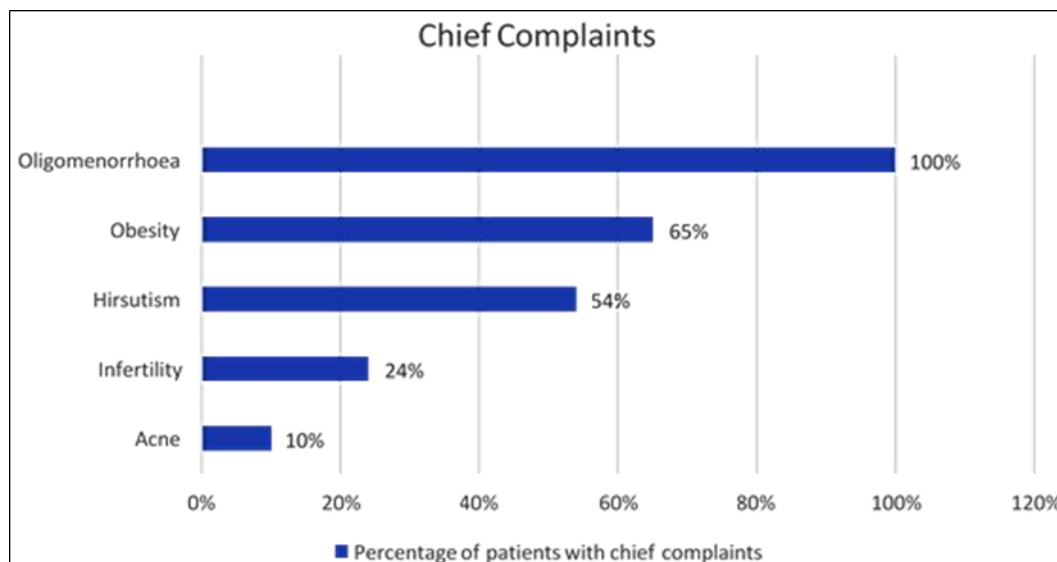

Fig 2: Percentage of Patient's Chief Complaints

Range of duration of the Main Complaints
The persistence of menstrual irregularity (oligomenorrhoea) ranged from 4 months to 2 years with a cycle length of>35 days. Hirsutism ranged from 4 months to 1 year, followed by obesity from 3 months to 2 years, infertility from 2 years to 4 years, and acne from 3 months to 1 year.

Distribution of BMI
As per the WHO criteria to classify obesity/overweight, the majority (35%) of the patients were overweight/preobese (BMI = 25 to 29.9 Kg/m^2). 30% of patients were obese with BMI >=30 Kg/m2.
The range of BMI was 17.8 to 38.75 Kg/m2 with a mean of 28.37 + 6.03 Kg/m2.

Distribution according to LMP
In the present study, 70% of patients were in the proliferative phase of the menstrual cycle i.e. within the first 14 days. 30% of patients had LMP more than 14 days but less than 90 days before.

Endometrial thickness and character
In this present study, the overall thickness of the endometrium ranged between 4 mm to 21mm. 70% of the patients presented in the proliferative phase with their endometrial thickness ranging between 4-9 mm. The rest 30% of patients who presented between 14 - 90 days from LMP, had their endometrial thickness ranging between 4-21 mm.
While the majority of patients (91%) showed normal, homogeneous endometrium, 6% of patients had thick and homogeneous endometrium and 3% of patients had thick and heterogeneous endometrium. These results are comparable with the study by Nagamani Peri *et al*. [12], in which out of 245 patients with polycystic ovary syndrome 93% had homogeneous endometrium with endometrial thickness ranging from 1-17mm. The rest 7% of patients had heterogeneous endometrium with thickness ranging from 4mm to 23mm.

Count of follicles per ovary
In the present study, follicle number was observed in the range of 7 to 16 per ovary with a mean of 12.8 + 2.31. Maximum number (68%) of patients were seen in the group of >12 follicles per ovary and 32% of patients had <12 follicles per ovary. The cut-off point was taken as per the Rotterdam consensus definition [8] of polycystic ovary syndrome.
These observations are similar to the study by Sidhmalswamy AG *et al*. [13] where the mean number of follicles were 12.2 + 2.17.

Distribution of follicles

88% of the patients had peripheral distribution of ovarian follicles in the present study. The rest 12% of patients had irregular distribution of ovarian follicles. Similar findings were observed in the study by Han LE [14] which showed 73% of patients with peripheral distribution of ovarian follicles.

Size of the follicles

The range of follicle size observed in this study was between 3 to 12 mm. Mean follicular size is 6.35 + 2.23 mm. In this study, most of the patients (91%) had 2-9 mm-sized follicles. 9% of patients had >9 mm follicles. due to the insensitivity of the ultrasound machine to detect follicles <2mm in size, they were not found in any patients.

The study done by Lujan ME *et al*. [15] showed that most of the patients with polycystic ovarian syndrome had a follicular size of <10mm. Only 4 patients had more than 10 mm follicles out of 16 patients.

Ovarian volume

In the present study, the range of ovarian volume was observed between 6 to 26cc with a mean volume of 13.8 + 4.81cc. 71% patients had ovarian volume >=10cc and 29% patients had <10cc ovarian volume. This is similar to the study by Sidhmalswamy AG *et al*. [13] where the mean ovarian volume was 15.25 + 6.11cc.

Percentage distribution of hormonal profile

In the present study, 87% of the patients had normal or low levels of FSH. 68% of the patients showed increased LH levels. LH/FSH ratio was raised to >2:1 in 41% of the patients. The testosterone levels were elevated in 80% of patients. 89% of the patients showed normal prolactin levels. The TSH levels were almost normal in 93% of the patients.

Table 1: Distribution of patients according to hormonal levels

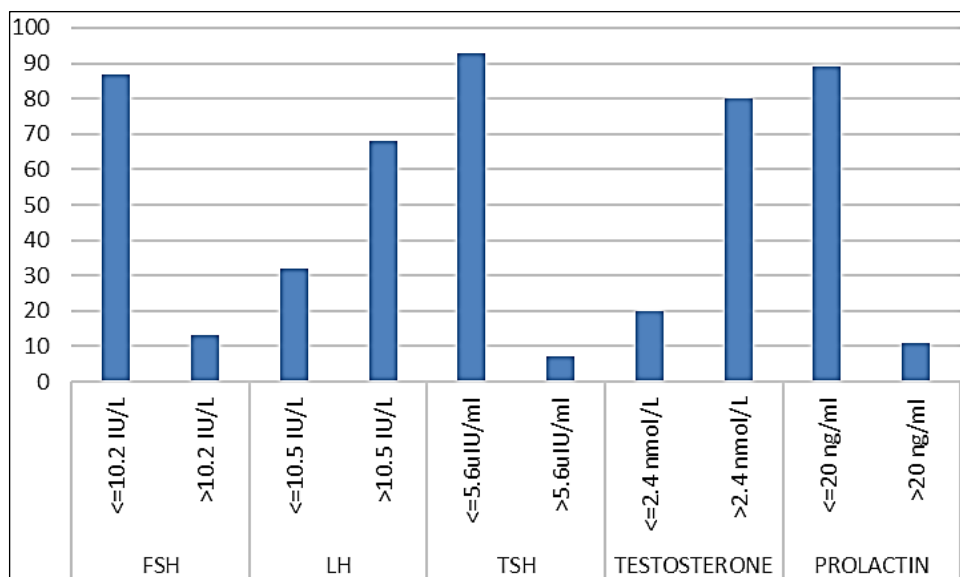| Hormonal levels	Number of patients	%	Reference value
FSH			
<=10.2 IU/L	87	87	Proliferative 2.5-10.2 IU/L
>10.2 IU/L	13	13	
LH			
<=10.5 IU/L	32	32	Proliferative 0.5-10.5 IU/L
>10.5 IU/L	68	68	
LH/FSH			
<=2:1	59	59	<1.2
>2:1	41	41	
TSH			
<=5.6uIU/ml	93	93	0.34-5.6 uIU/ml
>5.6uIU/ml	7	7	
Testosterone			
<=2.4 nmol/L	20	20	0.3-2.4 nmol/L
>2.4 nmol/L	80	80	
Prolactin			
<=20 ng/ml	89	89	3-20 ng/ml
>20 ng/ml	11	11	

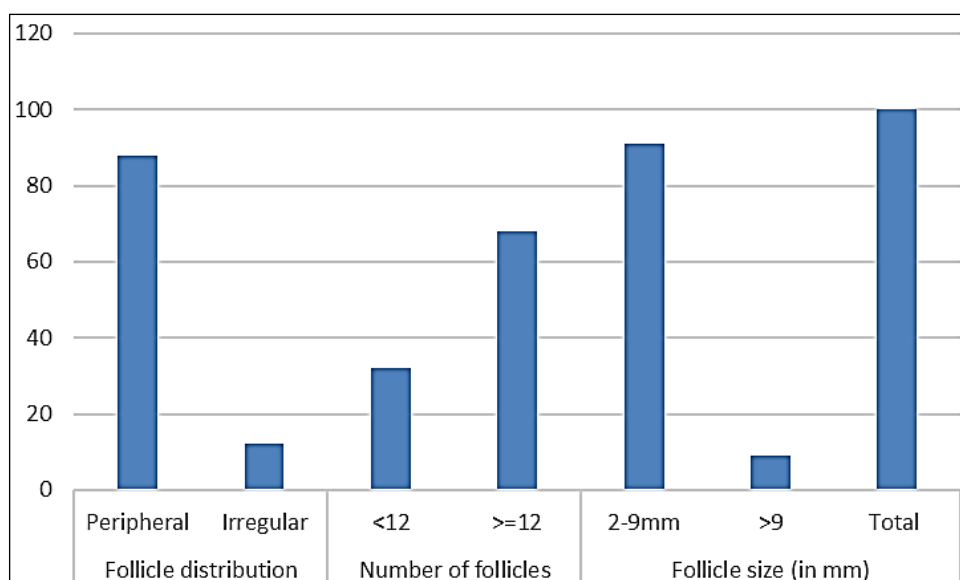**Fig 3:** Patient distribution according to hormonal level

Fig 4: Arrangement, number and size of follicles per ovary

Correlations between ultrasonographic ovarian, endometrial features and hormonal profile

It was observed that LH levels were raised in 67.6% of the patients with >/= 12 ovarian follicles, 67% of the patients with follicular size 2-9mm, 64.8% of the patients with ovarian volume >/= 10cc and 58.8% of patients with EMT >10mm.

The mean LH level is higher in patients with >12 ovarian follicles compared to patients with <12 follicles and also in patients with >10cc ovarian volume compared to patients with <10cc ovarian volume. The number of follicles, follicular size, and ovarian volume show positive correlations with LH levels. Among them, the correlations between the number of follicles and ovarian volume with LH level are found to be statistically significant.

Increased LH/FSH ratio (>2:1) was observed in 32.4% of patients with >12 follicles, 42% of patients with 2-9 mm sized follicles, and 32.4% of patients with >/= 10cc ovarian volume.

The mean LH/FSH ratio is greater in patients with >12 ovarian follicles compared to patients with <12 follicles. Mean LH/FSH is also higher in patients with > 10cc ovarian volume compared to patients with <10cc ovarian volume. The number of follicles, follicular size, and ovarian volume show positive correlations with LH/FSH ratio.

FSH levels were low to normal in 85.3% of the patients with >12 follicles, 86.8% of the patients with 2-9 mm follicular size, 87.3% of the patients with >10cc ovarian volume, and 94% of the patients with EMT>10mm. The mean FSH level is lower in patients with 2-9mm follicles compared to patients with >9mm follicular size. The number of follicles, follicular size and ovarian volume show positive correlations with low FSH levels.

High testosterone levels were observed in 82.4% of the patients with >12 follicles, 79.2% of patients

with 2-9 mm follicular size and 83.1% of patients with >10cc ovarian volume.

Mean testosterone levels are higher in patients with > 12 follicles, >9mm follicular size, and > 10cc ovarian volume compared to patients with <12 follicles, 2-9mm sized follicles and <10cc ovarian volume respectively. The number of follicles, follicular size, and ovarian volume show positive correlations with testosterone levels. Among them, the correlations between the number of follicles, and follicular size with testosterone level are statistically significant.

The number of follicles, follicular size, and ovarian volume showed insignificant negative correlations with prolactin and TSH levels.

Mean FSH levels are mild lower in patients with endometrial thickness above 10mm compared to patients with EMT between 1-5mm and 6-10mm. There is an insignificant negative correlation between endometrial thickness and FSH level.

No specific trends of correlations are found between endometrial thickness and other hormonal levels.

Correlations between Ultrasonographic Ovarian, Endometrial Features and Clinical Profile

In this study, the mean age of the patients is found to be higher in patients with >12 follicles, >9 mm follicular size, > 10cc ovarian volume, and EMT >10mm compared to patients with <12 follicles, 2-9mm sized follicles, <10cc ovarian volume and EMT <10mm respectively. There are positive correlations between patients' age and all the ovarian parameters as well as endometrial thickness. Among them, the correlation between number of the follicles and patients' age is found to be statistically significant.

Similar mean age of patients with polycystic ovary syndrome was observed by Sidhmalswamy AG *et al.* [13].

Mean BMI is greater in patients with > 12 follicles, >9 mm follicular size, > 10cc ovarian volume as well as patients with >10mm endometrial thickness compared to patients with <12 follicles, 2-9mm sized follicles, <10cc ovarian volume and EMT =<10mm respectively.

There are statistically significant positive correlations between patients' BMI and all the ovarian parameters as well as endometrial thickness. David Crosby *et al.* [16] observed similar findings where a modest positive correlation ($r = 0.24$) between BMI and endometrial thickness.

Positive correlations are found between all ovarian parameters and endometrial thickness with duration of menstrual irregularity (oligomenorrhoea). Among them, the positive correlation between the duration of menstrual irregularity and endometrial thickness is statistically significant.

Mean hirsutism severity scores (Modified Ferriman Gallwey score) are higher in patients with >12 ovarian follicles, >10cc ovarian volume, and >10mm endometrial thickness compared to patients with <12 follicles, <10cc ovarian volume, and EMT<10mm.

In this study, the number of follicles, follicular size, ovarian volume, and endometrial thickness show positive correlations with hirsutism severity scores.

Correlation between hormonal profile and clinical features

There are statistically significant positive correlations of LH level, LH/FSH ratio, and testosterone level with the severity of hirsutism in this study.

An insignificant positive correlation is observed between LH/FSH ratio and with duration of menstrual irregularity. An insignificant positive correlation is observed between patients' BMI and testosterone levels. Similar significant correlations of LH/FSH ratio and testosterone level with hirsutism were observed by Takahashi *et al.* [17].

Conclusion

- The ultrasonographic ovarian and endometrial findings in patients diagnosed with polycystic ovary syndrome showed statistically significant correlations with few clinical and hormonal indices.
- Thus this study concludes that ultrasonographic ovarian features like follicular number and ovarian volume show significant positive correlations with LH level as well as positive correlations with LH/FSH ratio. There are also significant positive correlations of hirsutism with LH level, LH/FSH ratio, and testosterone level, and significant positive correlations of testosterone level with the number of ovarian follicles.

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