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Assessment of Polycystic Ovarian Syndrome with Emphasis on Imaging Modalities

Urbain Muzafer[1,*], Sheikh Ansar ul Haq[2], Rahil Muzaffar[3], Kaisar Bhatt[4], Arushi Bagat[5], Aabid Hussian[1]

Abstract

Polycystic Ovarian Syndrome (PCOS) is a highly prevalent hormonal disorder that affects women during their reproductive age. It is linked to a wide range of health concerns, including disturbances in reproductive functions, metabolic abnormalities and an increased risk of cardiovascular diseases. Ultrasonography plays a crucial role in identifying polycystic ovarian morphology, which constitutes one of the key diagnostic criteria under the Rotterdam consensus. This prospective cross-sectional observational study was conducted at District Hospital Kulgam to compare the effectiveness of Transabdominal Sonography (TAS) and Transvaginal Sonography (TVS) in detecting polycystic ovaries. A total of 105 symptomatic women aged 15–45 years presenting with irregular menstruation, infertility, obesity, or clinical features of hyperandrogenism were included. Among them, 69 underwent TAS, 30 underwent TVS, and 6 underwent both modalities. Ovarian volume and antral follicle count were assessed according to standardized ultrasonographic criteria. The prevalence of polycystic ovarian morphology detected by TAS was 66.5%, while TVS detected 28.4% of cases. Not as much difference was observed between the two modalities in diagnosing polycystic ovaries. However, TVS provided better visualization in obese patients and in women unable to maintain adequate bladder distension. Despite its diagnostic advantages, TVS acceptance was limited, especially among unmarried women due to sociocultural concerns. The study concludes that both TAS and TVS are valuable imaging modalities in evaluating polycystic ovarian morphology. Clinical and biochemical correlation remains essential, as ultrasound findings alone are insufficient for diagnosing PCOS.

Keywords: Polycystic ovarian syndrome, PCOS, transabdominal ultrasound, transvaginal ultrasound, ovarian volume, antral follicle count

***Author for Correspondence**
Urbain Muzafer
E–mail: urbainmuzaffer@gmail.com

[1]Assistant Professor, Department of Radiodiagnosis and Imaging Technology, Bee Enn College of Nursing and Allied Sciences, Chak Balwal, Jammu, Jammu & Kashmir, India
[2]Radiographer, Department of Radiology, Govt Medical College, Jammu, Jammu & Kashmir, India
[3]Student, Department of Pharmacy, CT Group of College, Shahpur, Jalandhar, Punjab, India
[4]Lecturer, Department of Anaesthesia, Bee Enn College of Nursing and Allied sciences, Chak Balwal, Jammu, Jammu & Kashmir, India
[5]Tutor, Department of Anaesthesia, Bee Enn College of Nursing and Allied sciences, Chak Balwal, Jammu, Jammu & Kashmir, India

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INTRODUCTION

Polycystic Ovarian Syndrome (PCOS) is the most common endocrine condition affecting women in their reproductive years. First identified by Stein and Leventhal in 1935, the disorder is typically characterized by chronic anovulation, excess androgen levels, and presence of multiple cysts in ovaries. It is estimated to affect around 5–10% of women globally and is significant contributor to infertility.

PCOS is a complex, multifactorial condition that impacts reproductive, metabolic, and psychological health. Women with this disorder often experienced irregular menstrual cycles, excessive hair growth, acne, obesity, and difficulty conceiving. Beyond the reproductive issues, PCOS is strongly associated with insulin resistance, type 2 diabetes mellitus, abnormal lipid levels, hypertension, and

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increased risk of cardiovascular disease. Long term absence of ovulution can lead to prolonged estrogen exposure without progesterone balance, which may increase the risk of endometrial hyperplasia and carcinoma [1].

The underlying mechanism of PCOS involves disruption of the hypothalamic–pituitary–ovarian (HPO) axis. An Increased ratio of luteinizing hormone (LH) to follicle-stimulating hormone (FSH) promotes excess androgen production by ovarian theca cells. Additionally, elevated insulin levels enhance androgen synthesis and decrease sex hormone-binding globulin levels, thereby intensifying clinical features hyperandrogenism. These hormonal imbalances interfere with normal follicular growth, resulting in the formation of multiple small follicles that do not mature or ovulate [2].

The diagnosis of PCOS is established when at least two of the following three features are present:
1. Oligo- or anovulation,
2. Clinical or biochemical signs or hyperandrogenism, and
3. Polycystic ovarian morphology on ultrasound examination.

Ultrasonography, therefore, plays a crucial role in detecting characteristic ovarian changes associated with polycystic ovaries.

Polycystic ovarian morphology is identified when there are 12 or more follicles measuring 2–9 mm in diameter and/or an ovarian volume greater than 10 cm^3 in at least one ovary. Two main ultrasonographic techniques are commonly used for evaluation: transabdominal sonography (TAS) and transvaginal sonography (TVS). While TVS is considered superior due to higher resolution and better visualization, TAS remains widely used, particularly in adolescents and unmarried women [3].

Given the increasing prevalence of PCOS and the importance of imaging in its evaluation, this study aims to compare TAS and TVS in detecting polycystic ovarian morphology among symptomatic women.

REVIEW OF LITERATURE

PCOS has been extensively studied over the past decades, particularly regarding its epidemiology, pathophysiology, and imaging characteristics.

Epidemiological studies indicate that 5–10% of women of reproductive age meet the diagnostic criteria for PCOS. However, ultrasound studies suggest that up to 20–25% of women may demonstrate polycystic ovarian morphology without exhibiting clinical symptoms. This demonstrates that the presence of polycystic ovaries is alone not adequate for establishing diagnosis of PCOS [4].

Insulin resistance plays a key role in the development of PCOS. Around 30–60% of affected women are either overweight or obese. Elevated insulin levels stimulate the ovaries to produce excess androgens and contribute to arrest of follicular development. Increased LH levels and a higher LH/FSH ratio further enhance androgen production. These hormonal disturbances impair normal follicular maturation, leading to accumulation of multiple small follicles (2–9 mm) to within the ovaries [5].

Ultrasound examination has become fundamental tool in diagnosing polycystic ovarian morphology. The Rotterdam consensus established standardized diagnostic criteria, including follicle number and ovarian volume assessment. Ovarian volume is commonly calculated using the simplified ellipsoid formula:

$$\text{Ovarian volume} = 0.5 \times \text{length} \times \text{width} \times \text{thickness}.$$

Studies comparing TAS and TVS suggest that TVS offers superior image resolution, particularly in obese patients. TVS allows more accurate counting of antral follicles and better measurement of ovarian

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volume. However, TAS remains useful in patients who decline TVS or in adolescents where transvaginal examination is not appropriate.

Some studies report that transabdominal ultrasound may miss up to 30% of cases detected by TVS due to lower resolution and interference from abdominal adiposity. However, other research indicates that when performed properly with adequate bladder distension, TAS can provide comparable results in many cases.

Age-related variations also influence ovarian morphology. Antral follicle count declines with age, and ovarian volume decreases after the late reproductive years. Therefore, interpretation must consider patient age and menstrual status.

Proper reporting of ultrasound findings is essential. The report should include ovarian volume, follicle number, size range, and presence of dominant follicles or corpus luteum. Repeat scanning is recommended if a dominant follicle larger than 10 mm is present, as this may falsely elevate ovarian volume.

Overall, imaging plays a supportive but not definitive role in diagnosing PCOS. Clinical and biochemical correlation remains mandatory [6].

Pathophysiological Mechanisms in PCOS

The development of PCOS is multifactorial involving complex interplay of genetic, hormonal, and environmental influences. Among these insulin, resistance is considered a key contributing factor. Elevated insulin levels stimulate androgen production by ovarian theca cells and simultaneously reduce hepatic synthesis of sex hormone-binding globulin (SHBG), resulting in increased levels of free circulating testosterone. high androgen levels interfere with normal follicular development, leading to arrest of follicles at the antral stage.

In PCOS, the abnormal folliculogenesis is characterized by excessive recruitment of early-stage follicles along with impaired selection of a dominant follicle. Under normal physiological conditions, one follicle mature and ovulates under the influence of FSH. However, In PCOS elevated LH levels combined with excess androgen disrupts this process causing multiple small follicles typically measuring 2–9 mm, to accumulate within ovaries. These arrested follicles contribute to classical “string of pearls” appearance observed on ultrasound imaging [7].

Neuroendocrine disturbances also play an important role in PCOS. Increased pulsatile release of gonadotropin-releasing hormone (GnRH) leads to preferential LH secretion over FSH. This imbalance in the LH/FSH ratio further enhances androgen production and contributes to persistent anovulation. Additionally, dysfunction of adipose tissue in obese individuals promotes chronic low-grade inflammation and exacerbates insulin resistance.

Role of Ovarian Stroma

Earlier studies suggested that increased stromal echogenicity was a hallmark of polycystic ovaries. However, subsequent research clarified that it is stromal volume rather than intrinsic echogenicity that increases in PCOS. Stromal hypertrophy correlates positively with serum androgen levels. Increased stromal mass reflects heightened thecal cell activity, which contributes to androgen excess.

Although stromal assessment is not included in the Rotterdam criteria, ovarian volume serves as a reliable surrogate marker for stromal expansion. Measurement of ovarian volume remains clinically practical and reproducible compared to subjective assessment of stromal echogenicity [8].

Age-Related Variations

Antral follicle count and ovarian volume vary with age. Studies demonstrate a gradual decline in follicle number after 35 years of age. Therefore, interpretation of ultrasound findings must consider

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age-related physiological changes. Younger women may normally have higher follicle counts, which could mimic polycystic morphology without clinical significance [9].

Advances in Imaging Techniques

Three-dimensional ultrasound and automated follicle counting software have been introduced to improve diagnostic accuracy. These techniques reduce interobserver variability and provide more precise volumetric analysis. However, such advanced modalities are not widely available in resource-limited settings. Therefore, two-dimensional TAS and TVS remain the primary imaging methods in most hospitals, including the present study setting [10].

METHODOLOGY

This study was designed as prospective cross-sectional observational investigation carried out in the Department of Radiodiagnosis and Imaging at District Hospital Kulgam over a duration of three months.

Study Population

The study included a total of 105women both married and unmarried, between the ages 15–45 years were. Participants presented with clinical features suggestive of PCOS, including irregular menstrual cycle, infertility, obesity, and clinical signs of hyperandrogenism including hirsutism and acne.

Inclusion Criteria

- Women aged 14–45 years.
- Irregular or absent menstrual cycles.
- Clinical features of hyperandrogenism.

Exclusion Criteria

- Asymptomatic women.
- Age outside specified range.

Imaging Procedure

Ultrasound examinations were performed using the Mindray DC-70 color Doppler ultrasound system. TAS was conducted with a full urinary bladder to improve visualization. For TVS, patients emptied their bladder, and a 5 MHz vaginal probe was used after obtaining informed consent.

Ovarian volume was calculated using the simplified ellipsoid formula:

Ovarian volume = 0.5 × length × width × thickness.

Follicles measuring 2–9 mm were counted in longitudinal and transverse planes.

Data Analysis

Data were categorized according to age group and imaging modality. Results were expressed in percentages and compared between TAS and TVS.

RESULTS

Among the 105 women evaluated:

- 69 underwent transabdominal sonography (TAS).
- 30 underwent transvaginal sonography (TVS).
- 6 underwent both modalities.

The maximum number of cases was observed in age group between 20–30 years.

Polycystic ovarian morphology was detected in:

- 66.5% of patients by TAS.
- 28.4% of patients by TVS.

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No big difference was identified between the two imaging modalities in overall detection.

TVS demonstrated improved visualization in obese patients and in women who were unable to maintain adequate bladder distension for TAS. However, acceptance of TVS was limited, particularly among unmarried women due to hesitation and sociocultural concerns.

DISCUSSION

The findings of this study suggest that both transabdominal and transvaginal ultrasonography are effective in detecting polycystic ovarian morphology. While TVS is generally regarded as the gold standard due to superior resolution, this study demonstrated comparable detection rates between TAS and TVS in the general symptomatic population.

TVS showed better performance in obese patients, consistent with previous research. Increased abdominal adiposity can reduce the clarity of transabdominal imaging, making TVS more reliable in such cases. Additionally, TVS does not require bladder distension, which may be advantageous for certain patients.

However, sociocultural factors significantly influenced patient preference. Many unmarried women declined transvaginal examination due to hesitation or concerns about discomfort and menstrual hygiene. This emphasizes the significance of considering patient acceptability in clinical practice.

Importantly, PCOS is a syndrome and not solely an imaging diagnosis. The existence of cystic ovaries on ultrasound does not confirm PCOS without clinical or biochemical confirmation. Therefore, imaging findings must always be interpreted alongside hormonal and clinical evaluation.

The comparative evaluation of TAS and TVS in this study provides valuable insight into real-world diagnostic challenges. While literature often favors TVS due to superior resolution, practical limitations influence its use in routine clinical practice.

The higher prevalence detected by TAS in this study may reflect its wider application, as more patients underwent transabdominal scanning. The comparable diagnostic yield between TAS and TVS suggests that when performed meticulously, TAS can effectively identify polycystic ovarian morphology in most symptomatic patients.

TVS demonstrated better visualization in obese women. This is consistent with previous findings, as excess abdominal adiposity attenuates ultrasound waves and reduces clarity in transabdominal imaging. TVS eliminates interference from abdominal fat and does not require bladder distension, making it technically advantageous.

However, patient compliance remains a critical factor. Sociocultural barriers significantly influenced acceptance of TVS, particularly among unmarried women. This observation highlights the significance of individualized patient-centered imaging decisions. In conservative communities, TAS may serve as the first-line imaging modality, reserving TVS for cases where diagnostic ambiguity persists.

Another important consideration is that ultrasound morphology alone does not equate to PCOS. A significant proportion of women may have polycystic ovarian morphology without endocrine abnormalities. Overdiagnosis based solely on imaging can lead to unnecessary anxiety and treatment. Therefore, adherence to Rotterdam criteria, requiring at least two diagnostic features, is essential.

The study also emphasizes the significances of standardized reporting. Inclusion of ovarian volume, follicle count, and presence of dominant follicles improves diagnostic reliability and supports appropriate clinical management.

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Clinical Implications

The findings of this study have important clinical implications. Early identification of polycystic ovarian morphology allows timely intervention to prevent long-term metabolic complications such as diabetes and cardiovascular disease. Lifestyle modification, weight management, and hormonal therapy can be initiated earlier in high-risk patients.

Radiologists play a crucial role in multidisciplinary management of PCOS. Accurate measurement of ovarian volume and follicle count assists gynecologists in confirming diagnosis and planning treatment strategies. Additionally, ultrasound can help monitor response to ovulation induction therapy and assess risk of ovarian hyperstimulation syndrome.

In settings where TVS is not feasible due to patient refusal or limited resources, TAS remains a reliable alternative. Clear communication with patients regarding the purpose and safety of imaging modalities can improve acceptance rates.

Limitations of the Study

Despite its contributions, this study has certain limitations. The sample size was relatively small and restricted to a single institution, which may reduce the wider applicability of the results. In addition, the study period was limited to three months, and no long-term follow-up was carried out.

The relationship between hormonal profiles and imaging findings was not thoroughly analyzed, which could have improved diagnostic reliability. Moreover, the absence of advanced imaging modalities, such as three-dimensional, may have influenced the accuracy of follicle assessment.

Future research involving multiple centres, larger populations and combined biochemical evaluation is recommended to further validate and strengthen these findings.

Recommendations and Future Directions

Future research should focus on integrating imaging findings with hormonal and metabolic parameters to develop more comprehensive diagnostic models. Larger population-based studies may help refine follicle count thresholds according to age and ethnicity.

Implementation of standardized reporting protocols in radiology departments can enhance diagnostic consistency. Training programs for sonographers may reduce interobserver variability.

Furthermore, patient education regarding the importance and safety of transvaginal ultrasound may improve acceptance rates, thereby enhancing diagnostic accuracy in appropriate cases.

CONCLUSION

Polycystic Ovarian Syndrome is a frequently occurring hormonal disorder that has important effects on both reproductive health and metabolic function. Ultrasonography plays a vital role in identifying polycystic ovarian morphology, one of the diagnostic criteria under the Rotterdam guidelines. This study demonstrates that both transabdominal and transvaginal ultrasound are valuable tools in detecting polycystic ovaries. Although TVS provides superior image resolution and better visualization in obese patients, TAS remains widely accepted and practically feasible, especially in conservative populations. The choice of imaging modality should consider clinical indication, patient comfort, and sociocultural factors. Most importantly, ultrasound findings must be correlated with clinical symptoms and biochemical parameters to establish a definitive diagnosis of PCOS.

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