Original Research

STUDY OF CLINICALLY SUSPICIOUS POLYCYSTIC OVARIAN SYNDROME AND ITS RELATION WITH ULTRASONOGRAPHIC AND BIOCHEMICAL FINDINGS

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ABSTRACT

Background: Polycystic ovarian syndrome (PCOS) is one of the most common endocrine disorders affecting women of reproductive age and is associated with menstrual irregularities, hyperandrogenism, obesity, infertility, and metabolic disturbances. Clinical diagnosis alone may be misleading because of the heterogeneous nature of the syndrome. Ultrasonographic and biochemical investigations are therefore important for accurate diagnosis. This study was undertaken to evaluate the relationship between clinically suspected PCOS and ultrasonographic and biochemical findings.

Methods: A prospective observational case-control study was conducted at Durgapur Steel Plant Hospital, West Bengal, from June 2013 to June 2014. A total of 100 women aged 15–45 years were included, comprising 50 clinically suspected PCOS cases and 50 age-matched healthy controls. Diagnosis was based on ASRM/ESHRE 2003 criteria. Detailed clinical examination, BMI assessment, Ferriman-Gallwey scoring, ultrasonography, and biochemical investigations including LH/FSH ratio, serum testosterone, AMH, fasting insulin, lipid profile, and glucose tolerance test were performed. Statistical analysis was carried out using SPSS version 16, with $p<0.05$ considered significant.

Results: The majority of clinically suspected PCOS cases belonged to the 15–24 years age group (50%). Menstrual irregularity was the most common presenting complaint (92%), followed by hirsutism (38%), obesity (32%), infertility (22%), and acanthosis nigricans (22%). Oligomenorrhoea was the commonest menstrual abnormality (52%). Significant findings among cases included increased BMI ($p=0.017$), altered LH:FSH ratio (58%; $p<0.001$), stromal hyperechogenicity on ultrasonography (46%; $p=0.003$), altered lipid profile (24%; $p=0.004$), and association of obesity with elevated fasting insulin ($p=0.001$). Serum testosterone showed significant association with hirsutism and stromal echogenicity. However, serum AMH, fasting insulin, ovarian volume, and number of ovarian microcysts did not differ significantly between cases and controls.

Conclusion: Clinical suspicion alone is insufficient for an accurate diagnosis of PCOS. Ultrasonography serves as a useful non-invasive screening tool, while biochemical evaluation, particularly LH:FSH ratio and serum testosterone, improves diagnostic accuracy. Menstrual irregularity remains the most common clinical presentation. Increased stromal echogenicity and metabolic abnormalities were significantly associated with clinically suspected PCOS. Comprehensive clinical, ultrasonographic, and biochemical assessment is essential for proper diagnosis and management.

Keywords: Polycystic Ovarian Syndrome, PCOS, Ultrasonography, Biochemical Markers, LH/FSH Ratio, Hyperandrogenism, Menstrual Irregularity, Ovarian Stromal Echogenicity.

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INTRODUCTION

Polycystic ovarian syndrome (PCOS) is one of the most common endocrine disorders affecting women of reproductive age, with a prevalence of nearly 5–10%. It is characterized by menstrual irregularities, hyperandrogenism, obesity, infertility, and metabolic disturbances.[1] PCOS represents a heterogeneous spectrum of reproductive, endocrine, and metabolic abnormalities with varying clinical severity.[2] The Rotterdam consensus criteria proposed by the American Society for Reproductive

Medicine and the European Society for Human Reproduction and Embryology define PCOS by the presence of at least two of the following: oligo/anovulation, clinical or biochemical hyperandrogenism, and polycystic ovaries on ultrasonography.[3]

The exact etiopathogenesis of PCOS remains unclear and is believed to involve multiple mechanisms including insulin resistance, altered gonadotropin secretion, androgen excess, and genetic susceptibility.[4] Hyperinsulinemia and obesity contribute significantly to metabolic complications such as dyslipidemia, impaired glucose tolerance, and cardiovascular risk.[5] Clinical manifestations commonly include oligomenorrhoea, amenorrhoea, hirsutism, acne, obesity, infertility, and acanthosis nigricans.[6]

Diagnosis of PCOS relies on a combination of clinical evaluation, biochemical investigations, and ultrasonographic findings. An elevated LH:FSH ratio, increased serum testosterone, an altered lipid profile, and insulin resistance are frequently associated biochemical abnormalities.[7] Ultrasonography plays an important role in identifying characteristic ovarian morphology, including multiple peripheral follicles, increased ovarian volume, and stromal hyperechogenicity.

Over the years, diagnostic criteria for PCOS have evolved considerably, resulting in variability among studies and populations.[8] Although ultrasonography and biochemical markers improve diagnostic accuracy, considerable overlap exists between normal women and those with PCOS, making diagnosis challenging.[9] Recent studies also emphasize the role of ovarian stromal measurements and AMH (Anti-Müllerian Hormone) in improving diagnosis.[10]

Aims and Objectives

The present study was undertaken to evaluate clinically suspected cases of PCOS with the aim of identifying the most common clinical complaints in relation to different age groups and assessing their association with ultrasonographic and biochemical findings. The study also aimed to correlate various ultrasonographic features, such as ovarian volume, stromal echogenicity, and ovarian microcysts, with different clinical symptoms and signs of PCOS. In addition, the study intended to analyze important biochemical parameters including LH:FSH ratio, serum testosterone, fasting insulin, lipid profile, and anti-Müllerian hormone levels, and determine their relationship with the clinical manifestations of PCOS.

MATERIALS AND METHODS

Study Design: This observational analytical case-control study was conducted at the Department of Gynaecology, Durgapur Steel Plant Hospital, Durgapur, West Bengal, over a period of one year from June 2013 to June 2014. A total of 100 consented women aged between 15 and 45 years attending the gynaecology outpatient department were enrolled in the study. The study group consisted of 50 premenopausal women clinically suspected of having polycystic ovarian syndrome (PCOS) based on complaints such as menstrual irregularities, excess hair growth, weight gain, or infertility. The control group included 50 age-matched healthy women with regular menstrual cycles and without clinical or biochemical evidence of hyperandrogenism, thereby excluding the diagnosis of PCOS.

Inclusion and Exclusion Criteria

Women aged 15–45 years who were non-migratory, willing to participate in the study, and diagnosed with PCOS according to the ASRM/ESHRE 2003 criteria were included in the study. The diagnostic criteria included the presence of oligo/anovulation, clinical and/or biochemical hyperandrogenism, polycystic ovaries on ultrasonography, and an LH/FSH ratio ≥2. Patients with conditions that could influence hormonal or metabolic status were excluded from the study. These included women with diabetes mellitus, hypertension, thyroid disorders, renal disease, cardiovascular disease, Cushing's syndrome, congenital adrenal hyperplasia, androgen-secreting tumors, pregnant or lactating women; oral contraceptive users; patients receiving oral hypoglycemic or lipid-lowering agents; those on hormonal medications within the previous six weeks; and women with a previous history of ovarian surgery.

Sample Size Calculation

Based on previous studies [11] a total of 100 consented women aged 15-45 years were enrolled in this study. These 100 women were divided into two groups. 50 age-matched healthy female volunteers were the control and the rest 50 were cases.

The sample size calculation was powered at 80% to detect a relative risk of 2.5 for a positive response to an item among patients with PCOS relative to patients without PCOS, at an α of .05. This sample size also ensured that the precision of 95% confidence intervals around the sensitivity and specificity of our measure was no wider than ±10% (9.78%), provided that our observed values for sensitivity and specificity were 85% or greater.

Data Collection Procedure

Prior approval for the study was obtained from the Scientific and Ethical Committee of the hospital, and informed written consent was taken from all eligible participants before enrolment. Data collection was carried out using clinical examination tools including a stethoscope, sphygmomanometer, weighing machine, measuring tape, Ferriman-Gallwey scoring chart, and ultrasonography machine. A detailed history and physical examination were performed with emphasis on menstrual abnormalities, obesity, hirsutism, acne, acanthosis nigricans, secondary sexual

characteristics, and family history of metabolic disorders. BMI (Body Mass Index) was calculated using standard measurements of height and weight, and hirsutism was assessed using the Ferriman-Gallwey scoring system, where a score ≥8 was considered indicative of hyperandrogenism. All participants underwent transvaginal ultrasonography for assessment of ovarian morphology. Biochemical investigations including glucose tolerance test, fasting insulin, LH/FSH ratio, lipid profile, serum testosterone, 17-hydroxyprogesterone, anti-Müllerian hormone, prolactin, TSH, T3, and T4 were performed, preferably on the second day of menstruation. In women with irregular cycles, withdrawal bleeding was induced using progestogens before investigations. Standard definitions and reference values were used for menstrual abnormalities, obesity, infertility, hormonal parameters, and metabolic variables throughout the study.

Statistical Analysis

Categorical variables were expressed as frequency and percentage and were compared between the two groups using Pearson's Chi-square test for independence of attributes. Continuous variables were presented as mean ± standard deviation and compared using the unpaired Student's t-test. Statistical analysis was performed using SPSS software version 16.0. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Age Group (in years)	Cases n (%)	Controls n (%)	Total	P-Value	Significance
15–24	25 (50%)	21 (42%)	46	0.562	Not Significant
25–34	14 (28%)	19 (38%)	33		
35–45	11 (22%)	10 (20%)	21		
Total	50 (100%)	50 (100%)	100		

Table 1: Age Distribution of Clinically Suspected PCOS Cases and Controls

Table 1 illustrates that the majority of clinically suspected PCOS cases belonged to the 15–24 years age group (50%). No statistically significant difference was observed between cases and controls regarding age distribution (p=0.562).

Clinical Features	Frequency (%)
Menstrual Problems	46 (92%)
Hirsutism	19 (38%)
Obesity	16 (32%)
Infertility	11 (22%)
Acanthosis Nigricans	11 (22%)

Table 2: Distribution of Clinical Features among Suspected PCOS Cases

Table 2 observes that menstrual irregularity was the most common presenting complaint among clinically suspected PCOS patients (92%), followed by hirsutism, obesity, infertility, and acanthosis nigricans.

Menstrual Abnormality	Frequency (%)
Oligomenorrhoea	26 (52%)
Hypomenorrhoea	21 (42%)
Menorrhagia	10 (20%)
Amenorrhoea	5 (10%)
No Menstrual Problem	4 (8%)

Table 3: Types of Menstrual Abnormalities in Clinically Suspected PCOS Cases

Table 3 illustrates that oligomenorrhoea was the most common menstrual abnormality (52%) among suspected PCOS patients, followed by hypomenorrhoea and menorrhagia. Amenorrhoea was less common.

BMI Category	Cases n (%)	Controls n (%)	Total n (%)	P-Value	Significance
Underweight	1 (2%)	1 (2%)	2 (2%)	0.065	Not Significant
Normal	21 (42%)	33 (66%)	54 (54%)		
Overweight	18 (36%)	13 (26%)	31 (31%)		
Obese	10 (20%)	3 (6%)	13 (13%)		
Total	50 (100%)	50 (100%)	100 (100%)		

Table 4: Distribution of BMI among Cases and Controls

Table 4 shows that overweight and obesity were more common among suspected PCOS cases compared to controls. However, the difference was not statistically significant.

Ultrasonographic Findings	Cases n (%)	Controls n (%)
Ovarian Volume >10 ml	15 (30%)	9 (18%)
Number of Cysts >12	14 (28%)	8 (16%)
Stromal Hyperechogenicity Present	23 (46%)	9 (18%)

Table 5: Ultrasonographic Findings among Cases and Controls

Table 5 illustrates that stromal hyperechogenicity was the most common ultrasonographic finding among clinically suspected PCOS cases (46%), followed by increased ovarian volume and multiple ovarian microcysts.

Parameter	Cases Abnormal n (%)	Controls Abnormal n (%)	P-Value	Significance
Serum Testosterone	9 (18%)	6 (12%)	0.401	Not Significant
LH:FSH Ratio	29 (58%)	5 (10%)	<0.001	Significant
AMH	7 (14%)	5 (10%)	0.538	Not Significant
Fasting Insulin	5 (10%)	3 (6%)	0.461	Not Significant

Table 6: Biochemical Parameters among Cases and Controls

Table 6 observes that an altered LH:FSH ratio showed a statistically significant association with clinically suspected PCOS ($p<0.001$), whereas serum testosterone, AMH, and fasting insulin levels were not significantly different between groups.

Association	P-Value	Significance
Obesity vs Fasting Insulin	0.001	Significant
Hirsutism vs Serum Testosterone	0.016	Significant
Stromal Echogenicity vs Serum Testosterone	<0.001	Significant
Stromal Echogenicity vs Acanthosis Nigricans	0.044	Significant
Menstrual Problems vs LH:FSH Ratio	0.473	Not Significant
Menstrual Problems vs Stromal Echogenicity	0.867	Not Significant

Table 7: Association of Clinical Features with Biochemical and Ultrasonographic Findings in Cases

Table 7 illustrates significant associations between obesity and fasting insulin, hirsutism and serum testosterone, stromal echogenicity and serum testosterone, and stromal echogenicity with acanthosis nigricans. Menstrual abnormalities did not show significant association with ultrasonographic or biochemical parameters.

Variable	Cases Mean ± SD	Controls Mean ± SD	P-Value	Significance
Age (Years)	26.14 ± 8.99	26.86 ± 8.94	0.689	Not Significant
BMI (Kg/m²)	25.73 ± 4.56	23.77 ± 3.42	0.017	Significant
LH:FSH Ratio	2.36 ± 0.82	1.62 ± 0.42	<0.001	Significant
Testosterone (ng/dL)	55.93 ± 21.41	51.33 ± 20.70	0.277	Not Significant
Fasting Insulin (µIU/ml)	10.18 ± 6.25	10.26 ± 6.11	0.950	Not Significant
AMH (ng/ml)	1.65 ± 0.65	1.80 ± 0.68	0.246	Not Significant

Table 8: Mean Comparison of Clinical and Biochemical Variables between Cases and Controls

Table 8 observes that BMI and LH:FSH ratio were significantly higher among clinically suspected PCOS cases compared to controls, whereas testosterone, fasting insulin, and AMH levels did not differ significantly.

DISCUSSION

This prospective observational case-control study was conducted at Durgapur Steel Plant Hospital, West Bengal, from June 2013 to June 2014 to evaluate the relationship between clinically suspected polycystic ovarian syndrome (PCOS) and ultrasonographic and biochemical findings.

Age Distribution in Clinically Suspected PCOS Patients

The majority of clinically suspected PCOS cases in the present study belonged to the 15–24 years age group (50%), followed by 25–34 years (28%) and 35–45 years (22%). The mean age of cases was 26.14 ± 8.99 years, which was comparable to controls and showed no statistically significant difference. Similar observations were reported by Ramanand et al. [12], where the mean age was 22.05 ± 4.649 years, and by Beena et al. [13], who observed a higher prevalence of PCOS among women aged 15–24 years. However, Jajoo and Angik [14] reported a higher prevalence in the 21–30 year age group. The predominance of younger women in the present study may be due to increasing awareness and early clinical suspicion of menstrual irregularities and hyperandrogenic symptoms.

Clinical Features of PCOS

Menstrual irregularity was the most common presenting complaint, observed in 92% of clinically suspected cases. Hirsutism was present in 38%, obesity in 32%, infertility in 22%, and acanthosis nigricans in 22% of patients. Menstrual complaints were particularly common in women aged 35–45 years, whereas hirsutism was more common in the 25–34 year age group. Obesity and infertility were more frequently observed among older women. These findings are consistent with the heterogeneous clinical presentation of PCOS described in previous studies.[3,12]

Menstrual Abnormalities

Oligomenorrhoea was the most common menstrual abnormality (52%), especially among women aged 15–24 years. Hypomenorrhoea and menorrhagia were more frequent in older age groups. Similar findings were reported in a Taiwanese study where oligomenorrhoea and anovulation were common manifestations of PCOS.[15] Menstrual dysfunction in PCOS reflects chronic anovulation and altered hypothalamic-pituitary-ovarian axis function.

Ferriman–Gallwey Score and Hirsutism

Hirsutism assessed using the Ferriman–Gallwey scoring system showed that 22% of cases had a score of ≥8. The highest prevalence was noted in the 25–34 year age group. Although hirsutism was more common among cases than controls, the difference was not statistically significant. Similar observations were reported by Liang et al.[15] The variability in hirsutism among different populations may be influenced by ethnic and genetic factors. The Ferriman–Gallwey scoring system, though widely used, has limitations due to subjectivity and population-based variation.[16]

Body Mass Index

In the present study, 20% of suspected PCOS patients were obese and 36% were overweight. The mean BMI among cases was significantly higher than controls (25.73 ± 4.56 kg/m²). These findings are comparable to studies by Ramanand et al. [12] and Alnakash et al.[17], who also reported increased BMI among PCOS patients. Obesity is known to exacerbate insulin resistance and hyperandrogenism, thereby worsening the clinical manifestations of PCOS.

Ultrasonographic Findings

Among ultrasonographic parameters, stromal hyperechogenicity was the most common finding (46%), followed by increased ovarian volume (30%) and increased peripheral ovarian microcysts (28%). Overall ultrasonographic positivity was higher among cases than controls. Previous studies by Hann et al.[18] and Orsini et al.[19] also emphasized the importance of ovarian morphology in PCOS diagnosis. However, the overlap of polycystic ovarian morphology in normal women reduces its specificity. Increased stromal echogenicity is believed to correlate with ovarian androgen production and theca cell proliferation.[20]

Serum Testosterone

Elevated serum testosterone was observed in 18% of clinically suspected cases, but the difference from controls was not statistically significant. Earlier studies have demonstrated a stronger association between hyperandrogenemia and confirmed PCOS cases.[11] The lower prevalence in the present study may be because the study population included clinically suspected rather than confirmed PCOS patients.

LH: FSH Ratio

An abnormal LH:FSH ratio was observed in 58% of cases and showed a statistically significant difference compared to controls. The mean LH:FSH ratio among cases was 2.36 ± 0.82, which is comparable to findings by Dipankar et al.[12] Elevated LH secretion is a well-recognized endocrine abnormality in PCOS and contributes to ovarian androgen excess and anovulation.

Anti-Müllerian Hormone

Serum AMH levels did not differ significantly between cases and controls. Although recent studies suggest that elevated AMH levels may serve as a marker of increased follicular number in PCOS,[10] the present study did not support its routine use as a diagnostic marker.

Fasting Insulin Levels

No statistically significant difference in fasting insulin levels was observed between cases and controls. However, obese women showed significantly higher fasting insulin levels, indicating a strong relationship between obesity and insulin resistance. Similar observations have been reported in earlier studies.[10,15]

Relationship between Ultrasonographic Findings and Biochemical Parameters

No significant relationship was observed between ovarian microcysts and LH:FSH ratio or AMH levels. Similarly, obesity showed no significant association with ultrasonographic parameters such as ovarian volume, stromal echogenicity, or microcyst count. These findings suggest that

ultrasonographic morphology alone may not accurately reflect the hormonal or metabolic status of patients.

Hirsutism and Serum Testosterone

A statistically significant association was found between hirsutism and elevated serum testosterone levels. Similar findings were reported by Dipankar et al.[11] and Liang et al.[15] This evidence supports the role of biochemical hyperandrogenism in the pathogenesis of hirsutism in PCOS.

Stromal Echogenicity and Hyperandrogenism

Patients with stromal hyperechogenicity demonstrated significantly higher serum testosterone levels. Fulghesu et al., **[20]** also reported a significant relationship between stromal measurements and circulating androgen levels. Thus, stromal echogenicity may serve as an indirect indicator of ovarian androgenic activity.

Acanthosis Nigricans

A significant relationship was observed between acanthosis nigricans and stromal hyperechogenicity. However, the association between acanthosis nigricans and fasting insulin levels was not statistically significant. Previous studies have shown a correlation between acanthosis nigricans and insulin resistance.[21] The discrepancy may be due to the small sample size and lack of grading of acanthosis severity in the present study.

Menstrual Abnormalities and Hormonal/Ultrasonographic Findings

No significant association was observed between menstrual abnormalities and ultrasonographic findings, serum testosterone levels, or LH:FSH ratio. This finding supports the view that polycystic ovarian morphology alone is a nonspecific feature and may be present even in asymptomatic women.

Blood Pressure and Metabolic Parameters

Although elevated blood pressure was more common among cases than controls, the difference was not statistically significant. However, altered lipid profile was significantly more prevalent among suspected PCOS patients. Similar findings have been reported in both Indian and international studies.[21] These findings reinforce the metabolic implications of PCOS and the increased cardiovascular risk associated with the syndrome.

Glucose Tolerance Test

Impaired glucose tolerance was more common among suspected PCOS cases, although the difference was not statistically significant. Earlier studies have shown that women with PCOS are at increased risk of developing impaired glucose tolerance and type 2 diabetes mellitus.[22] The relatively younger age distribution in the present study may explain the lower prevalence of glucose intolerance.

Correlation between Ultrasonographic and Biochemical Findings

Only a small proportion of clinically suspected cases fulfilled both ultrasonographic and biochemical criteria for PCOS. While 46% of cases showed at least one positive ultrasonographic parameter, only 14–16% demonstrated both ultrasonographic abnormalities and biochemical hyperandrogenism. These findings indicate that diagnosis based solely on clinical suspicion is inadequate and highlight the importance of combining clinical, ultrasonographic, and biochemical assessments for accurate diagnosis of PCOS.

Limitations

The present study had certain limitations that should be acknowledged. The study duration and sample size were relatively small due to time constraints, which may have affected the accuracy and generalizability of the results. Owing to the broad and heterogeneous nature of PCOS, all relevant clinical and biochemical parameters could not be included. Infertility-related aspects were not evaluated comprehensively because a complete male and female infertility workup was beyond the scope of the study. Furthermore, as the study was conducted in an industrial area like Durgapur, environmental influences were not assessed, and the findings may not be directly comparable with population-based or general hospital studies. Additionally, some newer aspects explored in this study, particularly the relationship between ultrasonographic findings and clinical features, require further evaluation in larger future studies.

CONCLUSION

Based on the observations and results of the present study, it can be concluded that a diagnosis of PCOS based solely on clinical suspicion may be misleading, and ultrasonography serves as an effective non-invasive screening tool, while biochemical evaluation remains essential for a definitive diagnosis. Clinically suspected PCOS was more common among younger women aged 15–24 years, with menstrual irregularity being the most frequent presenting complaint, followed by hirsutism, obesity, infertility, and acanthosis nigricans. Oligomenorrhoea predominated in younger women, whereas hypomenorrhoea and menorrhagia were more common in older age groups. Hirsutism was more prevalent in women aged 25–34 years, while obesity and infertility were common in the 35–45 year age group. An altered lipid profile emerged as the most common metabolic abnormality among suspected PCOS patients. Significant associations were observed between PCOS and increased ovarian stromal echogenicity, altered LH:FSH ratio, serum testosterone levels, hirsutism, acanthosis nigricans, and obesity-related fasting insulin abnormalities, highlighting the multifactorial clinical, ultrasonographic, and biochemical nature of the disorder.

Author Contribution

Dr. Suchismita Das (First Author): Data collection, patient management, preparation of the original draft and literature review.
Dr. Arindam Mitra (Second Author): Conceptualization, investigation, case management and overall supervision.
Dr Ranjana Sarkar (Third Author): Manuscript writing, thorough critical review and editing.

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