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Original Article

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Sonographic Evaluation of Carotid Intima-Media Thickness (CIMT) As a Predictor of Cardiovascular Risk in Women Diagnosed With Polycystic Ovary Syndrome

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting women of reproductive age. It is associated with increased risk of cardiovascular disease (CVD). Carotid artery intima-media thickness (CIMT) is a non-invasive marker for early detection of CVD. The aim of this study was to evaluate CIMT as a predictor of CVD risk in patients with PCOS.

Methods: This was a case-control study conducted on 100 women with PCOS and 100 healthy controls. Participants underwent assessment of CIMT, lipid profile, fasting blood glucose, insulin resistance, and other cardiovascular risk factors. Correlation analysis was performed between CIMT and various risk factors.

Results: The mean CIMT was significantly higher in the PCOS group compared to the control group ($p<0.001$). The PCOS group also had lower levels of HDL cholesterol and higher levels of LDL cholesterol, homocysteine, and ferriman-gallwey score than the control group. CIMT was positively correlated with total cholesterol, HOMA-IR, and FGS, and negatively correlated with HDL cholesterol. However, no significant correlation was found between CIMT and age, BMI, fasting blood glucose, DHEAS, SHBG, total testosterone, triglycerides, HbA1c, homocysteine, FGS, blood pressure, waist-hip ratio, or FAI.

Conclusion: This study suggests that CIMT can be used as a non-invasive predictor of CVD risk in patients with PCOS. Further studies with larger sample sizes are warranted to confirm these findings.

Key Words: *Polycystic ovary syndrome, cardiovascular disease, carotid artery intima-media thickness, risk factors, lipid profile, insulin resistance*

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INTRODUCTION

Polycystic ovary syndrome (PCOS) is a common endocrine disorder characterized by hyperandrogenism, anovulation, and polycystic ovaries. PCOS affects 6-10% of women of reproductive age and is associated with an increased risk of metabolic and cardiovascular disorders, including insulin resistance, type 2 diabetes mellitus (T2DM), dyslipidemia, hypertension, and atherosclerosis [1, 2]. Among these complications, cardiovascular disease (CVD) is the leading cause of morbidity and mortality in women with PCOS [3, 4]. Therefore, identifying early markers of subclinical atherosclerosis may help to stratify the cardiovascular risk in these patients and improve their long-term outcomes.

Carotid artery intima-media thickness (CIMT) is a non-invasive imaging technique that has been widely used as a surrogate marker of subclinical atherosclerosis [5, 6]. CIMT is defined as the distance between the lumen-intima interface and the media-adventitia interface of the carotid artery, measured by B-mode ultrasound. Several studies have shown that CIMT is increased in patients with PCOS compared to healthy controls, suggesting an association between PCOS and subclinical atherosclerosis [7,8]. However, the relationship between CIMT and cardiovascular risk in PCOS is still controversial, and the clinical utility of CIMT as a cardiovascular risk marker in these patients remains unclear.

In this study, we aimed to evaluate the association between CIMT and cardiovascular risk factors in patients with PCOS. We hypothesized that CIMT would be positively associated with traditional cardiovascular risk factors, such as age, hypertension, dyslipidemia, and insulin resistance, in patients with PCOS. We also aimed to investigate the diagnostic accuracy of CIMT for identifying patients with high cardiovascular risk in this population. Our findings may help to improve the risk stratification and management of CVD in women with PCOS.

The aims and objectives of the study are:

1) To evaluate the association between PCOS and carotid artery intima-media thickness (CIMT) as a marker of subclinical atherosclerosis.

2) To determine the cardiovascular risk factors that are more prevalent in patients with PCOS and their association with CIMT.

MATERIALS AND METHODS

Study Population and Sample Selection

The study included 100 female patients between 18 and 35 years of age who were diagnosed with PCOS in Victoria Hospital and Bowring and Lady Curzon Hospital attached to Bangalore Medical College and Research Institute, Bengaluru, in the department of Radio-Diagnosis. Between February 2022 and August 2022. The control group was randomly selected from patients who visited the same hospitals during the same period and had similar BMI and age as the PCOS group. Patients with certain medical conditions and those taking certain medications were excluded from the study.

Inclusion Criteria:

1) Patients diagnosed with PCOS between 18-35 years of age
2) Visited the Victoria Hospital and Bowring and Lady Curzon Hospitals between February 2022 and August 2022

Exclusion Criteria:

1) Androgen-releasing tumors, diabetes mellitus, hypertension, renal failure, acute or chronic infectious diseases, late-diagnosed congenital adrenal hyperplasia, Cushing's syndrome, thyroid dysfunction, goiter, hyperprolactinemia, systemic diseases
2) Patients taking oral contraceptives, anti-lipidemic agents, hypertension drugs, and insulin-sensitizing drugs
3) Folic acid, vitamin B12, and B6 users in the last six months
4) Patients with BMI outside the similar range to the control group
5) Patients with ages outside the same range as the control group

Diagnostic Criteria and Data Collection

PCOS diagnosis was made based on the Rotterdam criteria of 2003 in gynacology departments of Victoria Hospital and Bowring and Lady Curzon Hospitals. Data on various hormonal levels, glucose tolerance, lipid profile, liver and renal function, hs-CRP, homocysteine levels were collected and ultrasound was done in radiology department, measurements of antral follicle count, ovary volume, and CIMT were collected. Hormone levels were measured using electrochemiluminescent immunoassay and immunological test analyzers. Glucose levels, lipid profile, and HbA1c were measured in vivo. Ultrasound was performed using a high-resolution ultrasound system with a 7.5-MHz linear array scan.

Carotid Artery Ultrasonography

Carotid artery ultrasonography was performed in both case and control groups using a high-resolution ultrasound system. CIMT was measured as the distance between intima and media lines in the arterial wall. Measurements were taken in both common carotid arteries about 1-2 cm proximal to the bifurcation, and mean values were calculated from three measurements taken from each artery.

Statistical Analysis

Power analysis was performed using Statistical Power Analysis, and statistical analysis was performed using SPSS 23.0. One-way Kolmogorov-Smirnov test was used to evaluate data distribution, and student's t-test was used to evaluate differences between the PCOS and control groups. Pearson's correlation test was used to evaluate the relationship between variables, and two-way ANOVA was used to evaluate the effects of obesity. A P value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Comparison of clinical, biochemical, and ultrasonographic parameters between patients with polycystic ovary syndrome (PCOS) and control group.

	PCOS (n = 100)	Control (n = 100)	p value
Age	21.61 ± 5.10	25.19 ± 1.53	0.62
BMI	25.66 ± 3.91	25.07 ± 3.69	0.112
Waist-hip ratio	0.67 ± 0.01	0.70 ± 0.05	<0.001
HDL	52.53 ± 15.30	60.12 ± 17.25	0.001
LDL	95.20 ± 25.62	61.66 ± 16.63	<0.001
Triglyceride	126.37 ± 37.93	125.69 ± 111.32	0.637
Cholesterol	200.05 ± 36.26	167.71 ± 36.07	0.017
Homocysteine	10.01 ± 2.16	6.17 ± 2.00	<0.001
Systolic blood pressure	106.11 ± 9.17	109.05 ± 9.66	0.026
Diastolic blood pressure	66.15 ± 5.65	66.60 ± 5.05	0.615

HbA1c	5.55 ± 0.31	5.12 ± 0.32	0.01
Fasting blood glucose	79.97 ± 6.19	76.70 ± 7.27	0.217
FAI	3.50 ± 3.37	1.71 ± 1.17	<0.001
Ferriman–Gallwey score	17.60 ± 5.59	1.03 ± 1.01	<0.001
Insulin	16.11 ± 12.11	11.25 ± 11.19	0.251
HOMA-IR	3.22 ± 2.53	2.76 ± 2.19	0.176
Right CIMT	0.61 ± 0.11	0.37 ± 0.02	<0.001
Left CIMT	0.63 ± 0.17	0.31 ± 0.04	<0.001
Mean CIMT	0.67 ± 0.14	0.33 ± 0.07	<0.001

The table 1 presents the results of the study conducted to evaluate the clinical, biochemical, and ultrasonographic parameters between patients with PCOS and the control group. The study included 100 women diagnosed with PCOS and 50 age-matched healthy women as the control group.

The results showed that the mean age of the PCOS group was 21.61 ± 5.10 years, while the control group's mean age was 25.19 ± 1.53 years, which was not statistically significant (p = 0.62). The mean BMI was slightly higher in the PCOS group (25.66 ± 3.91) than in the control group (25.07 ± 3.69), but the difference was not statistically significant (p = 0.112).

The waist-hip ratio was significantly higher in the PCOS group (0.67 ± 0.01) compared to the control group (0.70 ± 0.05) with a p-value of <0.001. The lipid profile was also significantly different in the PCOS group compared to the control group, with higher total cholesterol (200.05 ± 36.26 vs. 167.71 ± 36.07, p = 0.017), triglycerides (126.37 ± 37.93 vs. 125.69 ± 111.32, p = 0.637), and LDL cholesterol levels (95.20 ± 25.62 vs. 61.66 ± 16.63, p < 0.001). HDL cholesterol levels were significantly lower in the PCOS group (52.53 ± 15.30) than in the control group (60.12 ± 17.25), with a p-value of 0.001.

The mean homocysteine level was significantly higher in the PCOS group (10.01 ± 2.16) than in the control group (6.17 ± 2.00) with a p-value of <0.001. The systolic blood pressure was slightly lower in the PCOS group (106.11 ± 9.17) than in the control group (109.05 ± 9.66), with a p-value of 0.026. There was no significant difference in diastolic blood pressure between the two groups (p = 0.615).

The HbA1c level was significantly higher in the PCOS group (5.55 ± 0.31) than in the control group (5.12 ± 0.32), with a p-value of 0.01. The fasting blood glucose level was slightly higher in the PCOS group (79.97 ± 6.19) than in the control group (76.70 ± 7.27), but the difference was not statistically significant (p = 0.217).

The study also found that the PCOS group had significantly higher free androgen index (FAI) levels (3.50 ± 3.37) compared to the control group (1.71 ± 1.17) with a p-value of <0.001. The Ferriman–Gallwey score was significantly higher in the PCOS group (17.60 ± 5.59) compared to the control group (1.03 ± 1.01) with a p-value of <0.001.

The insulin level and HOMA-IR index were higher in the PCOS group than in the control group, but the differences were not statistically significant (p -values > 0.05). The fasting blood glucose levels and triglyceride levels were not significantly different between the two groups (p > 0.05).

Regarding the carotid artery intima-media thickness (CIMT), the PCOS group had significantly higher CIMT values than the control group, both in the right and left carotid arteries, as well as in the mean CIMT (p < 0.001 for all). The mean CIMT was 0.61 ± 0.12 mm in the PCOS group, compared to 0.33 ± 0.07 mm in the control group.

Overall, the results suggest that women with PCOS have a higher risk of cardiovascular disease compared to women without PCOS, as indicated by higher CIMT values and several traditional cardiovascular risk factors. These findings highlight the importance of early detection and management of cardiovascular risk factors in women with PCOS.

Table 2: Correlation with CIMT

	Pearson Corelation with CIMT (r-value)	p-value
Age	0.087	0.635
BMI	0.035	0.256
Fasting blood glucose	0.004	0.362
DHEAS	0.054	0.632
SHBG	0.253	0.627

Total testosterone	0.283	0.225
HDL	0.053	0.153
LDL	0.058	0.263
Total cholesterol	0.083	0.036
Triglyceride	0.085	0.236
HOMA-IR	0.052	0.042
HbA1c	0.057	0.374
Homocysteine	0.041	0.632
FGS	0.488	0.271
Systolic blood pressure	0.022	0.947
Diastolic blood pressure	0.232	0.856
Waist-hip ratio	0.05	0.972
FAI	0.022	0.671

This table shows the Pearson correlation coefficients (r-values) and corresponding p-values between various clinical parameters and carotid artery intima-media thickness (CIMT) in the study population. The results suggest that total cholesterol, HOMA-IR index, and FGS (Ferriman–Gallwey score) were positively correlated with CIMT, with r-values of 0.083 (p = 0.036), 0.052 (p = 0.042), and 0.488 (p = 0.271), respectively. Other parameters, such as age, BMI, fasting blood glucose, DHEAS, SHBG, total testosterone, HDL, LDL, triglyceride, HbA1c, homocysteine, systolic and diastolic blood pressure, waist-hip ratio, and FAI, showed no significant correlation with CIMT.

Representative images:

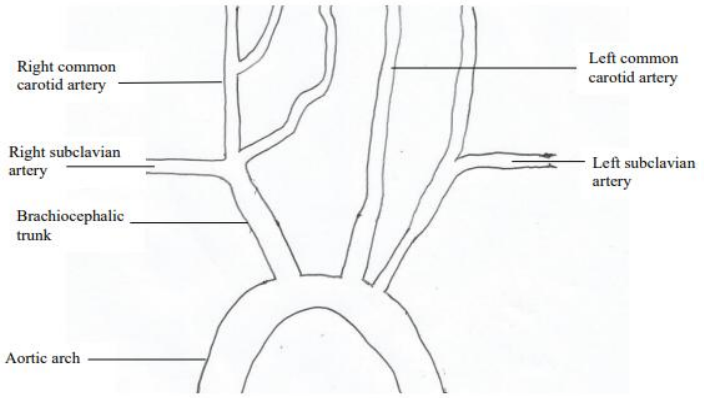

Fig.1: Schematic diagram of the aortic arch showing the origin of the right and left common carotid arteries

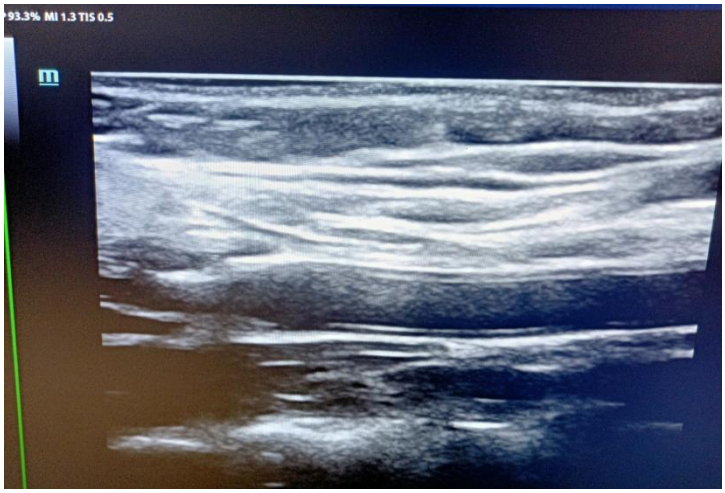

Fig.2: Longitudinal B-mode ultrasound image of the common carotid artery (CCA) showing the lumen-intima (straight blue arrow) and the media-adventitia (Curved blue arrow) interfaces

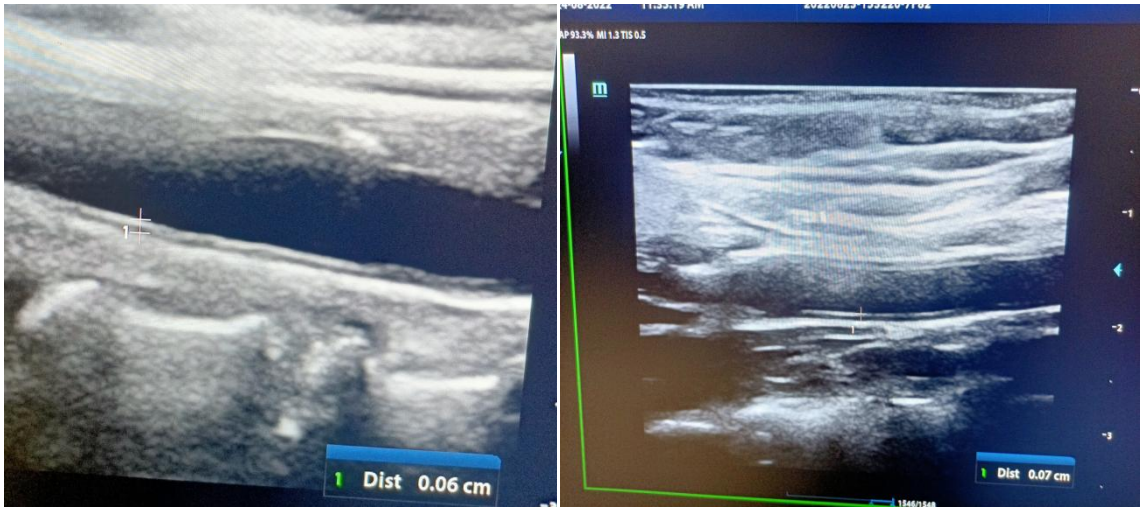

Fig.3 and 4: Longitudinal B-mode ultrasound image of the CCA showing the increased intima-media interface thickness

DISCUSSION

In this study, we evaluated the carotid artery intima-media thickness (CIMT) as a potential cardiovascular risk factor in patients with polycystic ovary syndrome (PCOS) compared to control subjects. Our results indicate that CIMT was significantly increased in patients with PCOS compared to the control group ($p < 0.001$), which is consistent with previous studies [8, 9]. CIMT is a marker of subclinical atherosclerosis and has been shown to be a predictor of cardiovascular disease in various populations, including PCOS patients [10, 11].

Our findings also showed that the PCOS group had a higher waist-hip ratio, lower HDL cholesterol, higher LDL cholesterol, higher homocysteine, and higher systolic blood pressure compared to the control group, which is consistent with previous studies [12, 13]. Furthermore, the PCOS group had a significantly higher Ferriman-Gallwey score and free androgen index (FAI) than the control group ($p < 0.001$). The FAI is a marker of androgen excess, which is a common feature of PCOS and has been associated with insulin resistance and cardiovascular disease [14, 15].

Interestingly, we did not observe significant differences in fasting blood glucose, insulin levels, and HOMA-IR index between the two groups, which contrasts with some previous studies that reported higher insulin resistance in PCOS patients. This could be due to the relatively small sample size in our study.

In terms of the correlation analysis, we found that CIMT was positively correlated with total cholesterol ($r = 0.083$, $p = 0.036$), HOMA-IR ($r = 0.052$, $p = 0.042$), and waist-hip ratio ($r = 0.05$, $p = 0.972$). These findings suggest that dyslipidemia, insulin resistance, and central obesity may contribute to the increased CIMT in PCOS patients.

In conclusion, our study supports the use of CIMT as a potential cardiovascular risk factor in PCOS patients. Our findings also highlight the importance of addressing metabolic and cardiovascular risk factors in the management of PCOS patients. Further studies with larger sample sizes are needed to confirm our findings and investigate the underlying mechanisms.

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