Original Article

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Relationship of Body Mass Index and Waist Hip Ratio with Insulin Resistance in Polycystic Ovarian Syndrome Patients

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ABSTRACT

Background: *Polycystic Ovarian Syndrome (PCOS) is the most common endocrinopathy among young women. Insulin resistance is a key feature in the pathogenesis of PCOS. Obesity, which is frequently associated with PCOS women, seems to amplify the degree of insulin resistance. The aim of the study is to investigate the relationship of insulin resistance with obesity in PCOS patients.*

Materials and methods: *This was a hospital based cross-sectional study comprising fifty (50) diagnosed PCOS patients aged between 20 and 40 years. This study was carried out in the Department of Biochemistry, Chittagong Medical College (CMC) and inpatients, outpatient Department of Gynaecology and Obstetrics, Chittagong Medical College Hospital (CMCH). Samples were taken by non-probability purposive sampling.*

Results: *The percentage of Insulin Resistance (IR) was 60% in this study. Mean age of PCOS patients was 30.6±0.65years. Obese PCOS patients with insulin resistance were 46% and overweight PCOS patients with IR were 48% in this study. There were also significant positive association of IR with increased BMI and waist hip ratio. Additionally 06% non-obese PCOS patients showed IR in this study cases.*

Conclusions: *This study suggested that abdominal obesity was a good predictor of IR among PCOS patients. So, waist circumference or waist hip ratio may be used as a screening tool for IR risk assessment among PCOS patients as an inexpensive, noninvasive and easy-to-detect marker. Hence early diagnosis and proper preventive management of these patients will reduce the reproductive complications.*

Key words: BMI; Fasting Insulin; HOMA-IR; Polycystic ovary; Waist hip ratio.

Introduction

Poly Cystic Ovary Syndrome (PCOS) is a common hormonal disorder that occurs in 5-10% of reproductive age group women.[1] It is the most prevalent endocrinopathy and common cause of infertility. Poly Cystic Ovarian Syndrome (PCOS) has also been Known by the name Stein-Leventhal Syndrome. The syndrome was officially recognized in the 1930's by Stein and Leventhal who associated Polycystic Ovaries (PCO) to the clinical features and includes a multisystem presentation, having its effects on the endocrine and reproductive systems, body weight, skin and hair.[2] This syndrome was characterized by oligomenorrhoea, infertility, heavy build and hirsutism in association with polycystic ovaries.[2] The syndrome is seen in the second and third decades of life and in about 50 percent of cases, includes obesity, hirsutism and acne.[3] PCOS is not only a leading cause of infertility. It can also be a risk factor for other health problems like type 2 diabetes mellitus, psychological disorders, cardiovascular diseases and various gynecological cancers like endometrial and ovarian cancer at an advanced stage of this disorder.[4]

The current definition of PCOS is based on Rotterdam Consensus Meeting in 2003. It defines the syndrome as presence of any two of the following three criteria:

i) Menstrual disturbance, oligomenorrhoea/anovulation.
ii) Clinical and/or biochemical signs of hyperandrogenism like acne, hirsutism etc., after other causes of hyperandrogenism have been ruled out.
iii) Ultrasound appearance of polycystic ovary (At least one ovary with 12 follicles or more, size: 2-9 mm, volume 10 ml).[5-6]

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When defined by the presence of oligomenorrhea and hyperandrogenism, 75% of women with PCOS have an LH level that is above the normal range for women in the early follicular phase and 94% have an increased LH to FSH ratio.[7] However, the Rotterdam criteria are now internationally accepted by the National Institute of Health (NIH) Australian guidelines and European societies.The most widely accepted diagnostic criteria is given by the National Institutes of Health (NIH) in 1990 defining it as hyperandrogenism and chronic anovulation in cases where secondary causes (Such as adult onset congenital adrenal hyperplasia, hyperprolactinema and androgen secreting neoplasm) have been excluded.[8]

The clinical features of PCOS are heterogeneous and may change throughout the lifespan, starting from adolescence to postmenopausal age.[9] Polycystic ovary syndrome consist of chronic anovulation, menstrual disturbance, hyperandrogenism, polycystic ovaries, obesity and metabolic syndrome.[10-11] Most of the late complications of PCOS are related to insulin resistance. Although all women with PCOS have evidence of insulin resistance, it is more pronounced in those with chronic anovulation.[12] It is suggested in many studies that 50% of patients with PCOS are obese.[12-13] Patients with PCOS have central obesity, increased deposition of fat around waist (an apple shaped instead of pear shaped). The obesity is android in type with increased waist to hip ratio and fat in anterior abdominal wall and mesentry.[13]

Central obesity is diagnosed when waist circumference is more than 80 centimeters and peripheral obesity when waist hip ratio is more than 0.85 centimeters for Asian women.[14] In addition to the clinical presentation, PCOS has the long term risk of developing type 2DM, Impaired Glucose Tolerance (IGT) gestational diabetes, frequent first trimester pregnancy loss and increased risk of cardiovascular disease and endometrial cancinoma.[15]

There are multiple methods available to measure insulin resistance. The gold standard for measuring insulin sensitivity is the hyperinsulinemic euglycemic clamp technique developed by DeFronzo et al.[16] Due to the complexity and time commitment of the dynamic methods, the most commonly used methods are the homeostasis model assessment of Insulin resistance (HOMA-IR). HOMA-IR is calculated as: [Fasting plasma insulin concentration (μU/ml)× fasting plasma glucose concentration (mmol/L)]/ 22.5.[17-18] HOMA-IR value >2.6 is considered as insulin resistance in this study.[19] Our purpose is to study the association of obesity with insulin resistance by HOMA-IR in women with PCOS in the Chattogram city.

Materials and methods

This cross-sectional study was carried out in the Department of Biochemistry and Department of Gynaecology and Obstetrics of Chittagong Medical College Hospital from July 2016 to June 2017. Permission of the study was taken from the ethical review committee of CMC and concerned departments. Fifty (50) woman aged between 20 to 40 years fulfilling the enrollment criteria were included by nonprobability purposive sampling.

Inclusion Criteria:

PCOS patient diagnosed on the basis of Revised Rotterdam Consensus 2003 criteria, patient having 2 out of 3 following criteria:

i) Chronic anovulation or amenorrhea
ii) Clinical or biochemical hyperandrogenism
iii) Polycystic ovary (By USG).

Exclusion Criteria:

i) Type 2 Diabetes Mellitus
ii) Hyperprolactinemia
iii) Thyroid disorder
iv) Refuse to give consent.

Serum insulin assay was carried out in ADVIA Centaur XP systems. Plasma glucose was estimated by glucose oxidase method in an automated Siemens analyzer. Insulin resistance was calculated using the HOMA model [HOMA-IR = fasting insulin (mIU/L) × fasting glucose (mmol/L)/22.5]. Those with HOMA-IR value > 2.6 were categorized as insulin resistant. Serum FSH, LH, Free Testosterone were measured by AdviaCentaur XP analyzer. All the data were processed and analyzed using computer-based statistical software. Confidence level was fixed at 95% and p value ≤0.05 was considered to be statistically significant. Different tests of statistical significance were done as appropriate.

Results

Table I Baseline characteristics of study cases (n=50)

Characteristics	Mean ± SEM	Range
Age (Years)	30.6 ± 0.65	20 - 35
BMI (kg/m²)	25.89 ± 0.38	21.15 – 31.51
Waist hip ratio	0.76 ± 0.01	0.62 - 0.87
Serum LH (mIU/ml)	8.78 ± 0.62	2.18 – 16.2
Serum FSH (mIU/ml)	4.77 ± 0.26	1.33 – 10.2
Serum Testosterone(mIU/ml)	3.79 ± 0.64	0.13 – 17.5
FPG (mmol/L)	5.73 ± 0.22	3.9 – 11.5
Serum Insulin (mIU/L)	17.86 ± 1.24	9 – 39.28
HOMA-IR	4.9 ± 0.49	2.09 – 15.12

Table I shows the mean values of age, BMI, waist hip ratio, serum LH, serum FSH, serum testosterone, FPG,fasting serum insulin and HOMA-IR (4.9 ± 0.49) in this study cases.

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Table II Percentage distribution of study cases (n=50)

Distribution of Cases	Percentage (%)
Presence of Insulin Resistance	30 (60%)
Obese	27 (54%)
Oligomenorrhea	46(92%)
Amenorrhea	04(08%)
Hirsutism	11(22%)

Table II shows that, insulin resistance, obese, oligomenorrhea, amenorrhea and hirsutism were present in 60%, 27%, 46%, 08% and 22% cases respectively in this study subjects.

Table III Distribution of BMI in PCOS patients with insulin resistance (n=50)

Obese PCOS Patients with Insulin Resistance	23 (46%)
Overweight PCOS Patients with Insulin Resistance	24 (48%)
Non-obese PCOS Patients with Insulin Resistance	03 (06%)

Table III demostated that,obese PCOS patients with insulin resistance were 46% and non-obese PCOS patients with insulin resistance were 06% in this study.

Table IV Association between increased Body Mass Index (BMI) and insulin resistance among the cases (n = 50)

BMI category (kg/m^2)	Category of HOMA-IR HOMA-IR ≤2.6	HOMA-IR >2.6	Total	χ^2 value	p value
BMI <25	16 (69.0%)	07 (31.0%)	23 (100.0%)	χ^2 =13.81	p <0.001
BMI ≥25	04 (15.0%)	23 (85.0%)	27 (100.0%)		(Significant)
Total	20 (40.0%)	30 (60.0%)	50 (100.0%)		

Table VI demonstrated that increased BMI was significantly associated with insulin resistancein cases.

Table V Association between increased Waist Hip ratio (W:H) and insulin resistance in cases (n = 50)

Waist Hip ratio (W: H)	Category of HOMA-IR HOMA-IR ≤2.6	HOMA-IR >2.6	Total	χ^2 value	p value
Increased (≤0.85)	19 (95.0%)	20 (66.7%)	39 (78.0%)	χ^2 = 5.61	p <0.001 (Significant)
Increased (> 0.85)	1 (5.0%)	10 (33.3%)	11 (22.0%)		
Total	20 (100%)	30 (100%)	50 (100%)		

Table V demonstrates that increased waist hip ratio was significantly associated with insulin resistance in cases.

Discussion

PCOS is an endocrine disorder with chronic anovulation, hyper androgenism and polycystic ovaries, with or without obesity. Hyper insulinemia/insulin resistance may be the primary feature of PCOS but some researchers proposed hyper androgenism as the key feature.[20] The co-existence of hyper insulinemia and hyper androgenism was suggested by some other investigators[21-22].

In this study PCOS was diagnosed by ultrasonography. Insulin resistance is a condition in which a given concentration of insulin produces a less than expected biological effect. The percentage distribution of Insulin Resistance (IR) in our sample population was found to be 60%. In a study from Baghdad the prevalence of insulin resistance showed 76.5% where the insulin resistance was calculated by HOMA model.[23] Insulin resistance was also reported 52.8% in North Indian and 31% in Pakistani women with PCOS.[24,25] On the otherhand, a study from Pakistan the mean age of woman with PCOS was reported 27.1 ± 33.5 years which is close to our study.[26]

Though a woman may be genetically predisposed to developing PCOS, it is only the interaction of environmental factor (Obesity) with the genetic factors that results in clinical expression of the PCOS. Women with PCOS showed increased prevalence of overweight, obesity and central obesity compared with women without PCOS.[27] Abdominal or visceral adiposity and obesity might contribute to ovarian and adrenal hyperandrogenism by mechanism independent of insulin resistance including low-grade chronic inflammation, secretion of adipokines such as leptin that exert direct effects on the ovary and local metabolism of sex steroids and cortisol in visceral fat.[28] In this study, 46% obese PCOS Patients and 48% overweight PCOS patients showed Insulin Resistance. Additionally, increased BMI and waist hip ratio were significantly associated with insulin resistance in this study cases. Fouzia Adil et al showed in their study that 50% cases were obese in PCOS patients that was similar to our study result.[29] Besides a Korean study showed that, 10.3% PCOS patients were overweight and 28.4% were obese.[30] This result was lower than that of our study.

Although obesity is a common and major pathogenic characteristic in PCOS, it is not present in all cases. In a previous report, we also found that non-obese women with PCOS showed significant insulin resistance compared to their age and BMI comparable control subjects[31]. Additionally it is observed in this study that 06% non-obese PCOS patients have insulin resistance. S. Toprak, et al suggested in their study that insulin resistance in non-obese PCOS patients are related to LH and free testosterone levels.[32]

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Conclusion

This study suggested that abdominal obesity is a good predictor of insulin resistance and metabolic syndrome among PCOS patients. Waist circumference or waist hip ratio may be used as a screening tool for insulin resistance and metabolic syndrome risk assessment among PCOS patients as a sensitive, inexpensive, noninvasive and easy-to-detect anthropometric marker.

Recommendation

We recommend large-scale studies to validate our observations.

Disclosure

All the authors declared no competing interest.

References

1. Sirmans S.M. and Pate K.A. Epidemiology, diagnosis and management of polycystic ovary syndrome. ClinEpidemiol. 2014; 6: 1–13.

2. Farquhar C. Introduction and history of polycystic ovary syndrome. In: Kovacs G, Norman R, editors. Polycystic Ovary Syndrome. 2nd ed. Cambridge, UK. Cambridge University Press. 2007:4–24.

3. Dabadghao P, Roberts BJ, Wang J, Davies MJ, Norman RJ. Glucose tolerance abnormalities in Australian women with polycystic ovary syndrome. Med J. 2007; 187(6): 328-331.

4. Ashraf S, Nabi M, Rasool SUA et al. Hyperandrogenism in polycystic ovarian syndrome and role of CYP gene variants: A review. Egypt J Med Hum Genet. 2019; 20: 25.

5. Rotterdam ESHRE/ASRM Sponsored PCOS Consensus Work Shop Group. Revised 2003 Consensus on Diagnostic Criteria and Long Term Health Risk Related to PCOS. FertilSteril. 2004; 81: 19-25.

6. Franks S. Diagnosis of Polycystic Ovarian Syndrome in Defense of Rotterdam Criteria. Journal of Clinical Endocrinology and Metabolism. 2005; 2(3): 786-789.

7. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. National Institutes of Health. Obes Res. 1998; 6(S-2): 51-209S.

8. Chanukvadze D, Kristesashvili J, Kvashilava N. Correlation of biochemical markers and clinical signs of hyperandrogenism in women with Poly Cystic Ovary Syndrome (PCOS) and women with Non-Classic Congenital Adrenal Hyperplasia (NCAH). Iran J Reprod Med. 2012; 10(4): 307-314.

9. Azziz R. An Update on Polycystic Ovary Syndrome: Bradley Trivax.US Endocrinology. 2007; 1:84-87.

10. Dipankar B, Kumar MS, Satinath M, Mamata P. Clinical Correlation with Biochemical Status in Polycystic Ovary Syndrome. Journal of Obstetrics &Ganecology of India. 2005; 55(1): 67-71.

11. Norman RJ, Dewailly D, Legro RS, Hickey TE. Polycystic ovary syndrome. Lancet. 2007; 370(9588): 685-697.

12. Lobo RA, Carmina E. Importance of Diagnosing PCOS. Annuals of Internal Medicine. 2000; 32: 989-993.

13. Nager EA. Prompt Treatment Is Necessary to Control and Prevent Further Progression of PCOS Related Insulin Resistance, Dyslipidemia, Type 2 Diabetes, Cardiovascular Disease and Cancer. Search Archives. 2006; 14(1): 49.

14. Wongwananuruk T, Rattanachaiyanont M, Indhavivadhana S et al. Prevalence and clinical predictors of insulin resistance in reproductive-aged thai women with polycystic ovary syndrome. Int J Endocrinol. 2012; 2012: 529184.

15. Rojas J, Chávez M, Olivar L et al. Polycystic ovary syndrome, insulin resistance and obesity: Navigating the pathophysiologic labyrinth. Int J Reprod Med. 2014; 2014: 719050.

16. DeFronzo RA, Tobin JD, Andres R. Glucose clamp technique: A method for quantifying insulin secretion and resistance. Am J Physiol. 1979; 237(3): E214-E223.

17. Matthews DR, Hosker JP, Rudenski AS et al. Homeostasis model assessment: insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia. 1985; 28(7): 412–419.

18. Wallace TM, Levy JC, Matthews DR. Use and abuse of HOMA modeling. Diabetes Care. 2004; 27(6):1487–1495.

19. Qu HQ, Li Q, Rentfro AR, Fisher-Hoch SP, McCormick JB. The definition of insulin resistance using HOMA-IR for Americans of Mexican descent using machine learning. PLoS One. 2011; 6(6): e21041.

20. Yousouf R, Khan M, Kounsar Z, Ahangar S, Lone WA. Polycystic Ovarian Syndrome: Clinical Correlation with Biochemical Status. Surgical Science. 2012; 3(5): 245-248.

21. Salley KE, Wickham EP, Cheang KI et al. Glucose intolerance in polycystic ovary syndrome: A position statement of the Androgen Excess Society. J ClinEndocrinolMetab. 2007; 92(12): 4546-4556.

22. Gourgari E, Spanakis E, Dobs AS. Pathophysiology, risk factors and screening methods for prediabetes in women with polycystic ovary syndrome. Int J Womens Health. 2016. 10; 8: 381-387.

23. Al-Bayatti AA. Insulin resistance and upper body obesity in polycystic ovarian syndrome. Middle East Fertility Society J. 2006;11(3): 202-209.

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24. Mangangcha IR, Rathore VS, Singh IK, Bidyarani O. Metabolic characteristics of polycystic ovarian syndrome and its associated genetic polymorphisms in Indian women population. J Nat SciBiol Med. 2011;2:138.

25. Riaz M, Basit A, Fawwad A et al. Frequency of insulin resistance in patients with polycystic ovary syndrome: A study from Karachi, Pakistan. Pak J Med Sci. 2010;26(4): 791-794.

26. Haq F, Aftab O, Rizvi J. Clinical, biochemical and ultrasonographic features of infertile women Poly cystic ovarian syndrome. J Coll Physicians Surg Pak. 2007;17(2):76-80.

27. Lim SS, Davies MJ, Norman RJ, Moran LJ. Overweight, obesity and central obesity in women with polycystic ovary syndrome: A systematic review and meta-analysis. Hum Reprod. 2012;18(6): 618-637.

28. Escobar-Morreale HF, San Millán JL. Abdominal adiposity and the polycystic ovary syndrome. Trends EndocrinolMetab. 2007; 18(7): 266-272.

29. Adil F, Ansar H, Munir AA. Polycystic Ovarian Syndrome and Hyperinsulinemia. Journal of Liaquat University of Medical and Health Sciences. 2005; 4(3): 89-90.

30. Lee H, Jee-Young O, Yeon-Ah S, Cho WY. The prevalence and risk factors for glucose intolerance in young Korean women with polycystic ovary syndrome. Endocrine. 2009;36(2): 326-332.

31. Park HR, Choi YJ, Lee H-J et al. Phenotypic characteristics according to insulin sensitivity in non-obese Korean women with polycystic ovary syndrome. Diabetes Res ClinPract. 2007. 77S: 233–237.

32. Toprak S, Yönem A, Cakir B et al. Insulin resistance in non-obese patients with polycystic ovary syndrome. Horm Res. 2001; 55(2): 65-70.