Original article

eISSN 2799-8010
J Yeungnam Med Sci 2023;40(Suppl):S17-S22
https://doi.org/10.12701/jyms.2023.00143

JYMS
JOURNAL OF YEUNGNAM MEDICAL SCIENCE

Evaluation of periodontal status in women with polycystic ovary syndrome versus healthy women: a cross-sectional study

Sandhya Pavankumar[1], Pavan Kumar Yellarthi[2], Sandeep JN[3], Ramanarayana Boyapati[4], Trinath Kishore Damera[1], Naveen Vital Kumar G[1]

[1]Department of Periodontics, GITAM Dental College and Hospital, Visakhapatnam, India
[2]Department of Oral Medicine and Radiology, GITAM Dental College and Hospital, Visakhapatnam, India
[3]Department of Periodontics, V.S Dental College and Hospital, Bengaluru, India
[4]Department of Periodontics, Sibar Institute of Dental Sciences, Guntur, India

Background: Polycystic ovary syndrome (PCOS) affects approximately 4% to 12% of females of reproductive age. Previous studies have shown an association between systemic and periodontal diseases. This study aimed to compare the prevalence of periodontal disease in women with PCOS and healthy women.

Methods: A total of 196 women aged 17 to 45 years were included in this study. Oral hygiene index-simplified (OHI-S), gingival index (GI), community periodontal index (CPI), and loss of attachment (LA) were assessed. Individuals who smoked, were pregnant, had any systemic disease (such as type 1 or type 2 diabetes mellitus, cardiovascular disease, malignancy, osteoporosis, and thyroid dysfunction), had a history of systemic antibiotic use in the past three months, or received any periodontal intervention in the past 6 months of screening were excluded. Student *t*-test was used to analyze the data. A *p*-value of <0.05 was considered statistically significant.

Results: Despite similar OHI-S scores ($p=0.972$) in the two groups, women with PCOS had significantly higher GI, CPI, and LA scores than healthy women ($p<0.001$).

Conclusion: Periodontal disease was more prevalent in women with PCOS than in healthy women. This finding may be due to the synergistic effects of PCOS and periodontitis on proinflammatory cytokines. PCOS may have an effect on periodontal disease, and vice versa. Hence, education on periodontal health and early detection and intervention for periodontal diseases is of paramount importance in patients with PCOS.

Keywords: Community periodontal index; C-reactive protein; Insulin resistance; Periodontal attachment loss; Periodontal diseases; Polycystic ovary syndrome

Introduction

Polycystic ovary syndrome (PCOS) is a highly common condition affecting approximately 4% to 12% of females of reproductive age [1,2]. Although this syndrome is heterogeneous in nature, chronic anovulation and hyperandrogenism are its hallmarks. In 1935,

Received: February 4, 2023 • **Revised:** March 29, 2023 • **Accepted:** April 4, 2023 • **Published online:** May 8, 2023
Corresponding author: Sandhya Pavankumar, MDS
Department of Periodontics, GITAM Dental College and Hospital, Rushikonda, Visakhapatnam, Andhra Pradesh 530045, India
Tel: +91-891-2840351 • Fax: +91-891-2790033 • E-mail: sandhyapavankumar25@gmail.com

Stein and Leventhal were among the first to describe this condition. Later, great progress was made in understanding the pathogenesis of PCOS owing to its neuroendocrine underpinnings [3] and the link between insulin resistance, obesity, and PCOS [4]. Given the present knowledge of PCOS, it is important that the treatment approach should not only treat infertility and hirsutism but also consider the long-term hazards related to insulin resistance [1].

Metabolic abnormalities such as dyslipidemia, type 2 diabetes mellitus, endometrial carcinoma, and cardiovascular disease seem to be associated with PCOS. However, obesity (abdominal phenotype), insulin resistance, altered lipid levels, and hyperinsulinemia are primary characteristic features of PCOS [5,6].

Hyperinsulinemia and insulin resistance play critical roles in PCOS pathogenesis. The initiation and maintenance of hyperandrogenism are closely associated with obesity and hyperinsulinemia [7]. Increased androgen levels affect insulin sensitivity in target tissues, leading to an insulin-resistant state. The presence of low-grade inflammation due to insulin resistance explains the increased levels of C-reactive protein (CRP) seen in this syndrome [8-10].

Periodontitis, a chronic inflammatory disease initiated by lipopolysaccharides produced by periodontopathic bacteria, eventually leads to attachment loss and alveolar bone loss [11]. Elevated CRP levels have been observed in patients with periodontitis. Hence, the increased CRP level associated with low-grade chronic inflammation is emerging as a plausible etiological mechanism linking systemic and periodontal diseases [12].

Increased levels of proinflammatory cytokines such as interleukin (IL)-1 and tumor necrosis factor-α (TNF-α) observed in the serum and gingival crevicular fluid of patients with periodontitis [13] might also contribute to insulin resistance [14]. The pathognomonic states of PCOS and chronic periodontitis may explain the association between these conditions.

Therefore, this study aimed to compare the prevalence of periodontal disease in women with PCOS and healthy women.

Methods

Ethical statements: Informed written consent was obtained from all study participants. Approval for the study protocol was procured from the participating institutions. Ethical clearance for the study was acquired from the ethical committee of GITAM Dental College (approval No. 20-10977GDH).

1. Study design

A total of 196 women (98 per group in the PCOS and healthy groups) aged 17 to 45 years participated in this study. Participants were selected from the outpatient departments of the Department of Obstetrics and Gynaecology, Department of Radiology, GITAM Medical College and Hospital; OMNI RK Super Specialty Hospital; Medi Plaza Visakhapatnam; and Department of Periodontics, GITAM Dental College and Hospital, Visakhapatnam, India.

Female patients diagnosed with PCOS and having ≥ 24 teeth were included in the PCOS group. Females who were regularly menstruating formed the healthy control group. Individuals who smoked, were pregnant, had any systemic diseases (such as type 1 or type 2 diabetes mellitus, cardiovascular disease, malignancy, osteoporosis, and thyroid dysfunction), were treated with systemic antibiotics in the past 3 months, or had any periodontal intervention in the 6 months prior to screening were excluded.

2. Clinical parameters

Oral hygiene index-simplified (OHI-S), gingival index (GI), community periodontal index (CPI), and loss of attachment (LA) were recorded [15].

3. Statistical analysis

The Student *t*-test and multivariate analysis of covariance were used to analyze the data. Statistical significance was set at $p < 0.05$. IBM SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA) was used for the statistical analysis.

Results

The age distribution among patients with PCOS and those who were healthy ranged from 17 to 45 years. The groups did not differ significantly ($p = 0.740$) in age (Table 1).

1. Oral hygiene index-simplified

When the mean OHI-S scores were compared between the PCOS (2.10 ± 0.70) and healthy (2.10 ± 0.70) groups, oral hygiene status was not significantly different ($p = 0.997$) between them (Table 2).

2. Gingival index

GI was significantly ($p < 0.001$) higher in the PCOS group (1.50 ± 0.42) than in the healthy group (1.07 ± 0.16), demonstrating significantly higher gingival inflammation in the PCOS group (Table 2).

Table 1. Distribution of age among individuals with PCOS and those who are healthy

Variable	PCOS group	Healthy individuals	t-value	*p*-value
No. of patients	98	98		
Age (yr)	22.82 ± 4.68 (17–45)	23.36 ± 5.589 (17–45)	0.331	0.74

Values are presented as number only or mean ± standard deviation (range).
PCOS, polycystic ovary syndrome.
Statistical significance was set at $p < 0.05$.

Table 2. Comparison of OHI-S, GI, CPI, and LA scores between women with PCOS and those who are healthy

Index	PCOS group	Healthy individuals	*p*-value
OHI-S	2.109 ± 0.070 (1.971–2.248)	2.107 ± 0.070 (1.968–2.246)	0.977
GI	1.501 ± 0.032 (1.438–1.565)	1.077 ± 0.032 (1.013–1.140)	0.001[a]
CPI	2.991 ± 0.057 (2.879–3.104)	2.366 ± 0.057 (2.253–2.478)	0.001[a]
LA	0.991 ± 0.055 (0.884–1.099)	0.396 ± 0.055 (0.289–0.504)	0.001[a]

Values are presented as mean ± standard error (95% confidence interval).
OHI-S, oral hygiene index-simplified; GI, gingival index; CPI, community periodontal index; LA, loss of attachment; PCOS, polycystic ovary syndrome.
[a] $p < 0.05$ (statistical significance).

3. Community periodontal index

The mean CPI was 2.99 ± 0.52 in the PCOS group and 2.37 ± 0.59 in the healthy group. The PCOS group exhibited significantly ($p < 0.001$) greater mean CPI scores than the healthy group (Table 2).

4. Loss of attachment

The mean LA was 0.99 ± 0.52 in the PCOS group and 0.40 ± 0.55 in the healthy group. The PCOS group demonstrated significantly higher mean LA scores than the healthy group ($p < 0.001$), indicating increased destruction of periodontal attachment in the PCOS group (Table 2).

Discussion

PCOS is a complex and heterogeneous endocrinopathy characterized by a wide array of clinical symptoms. A single causative factor cannot fully account for the entire range of irregularities associated with this disorder [1]. After Stein and Leventhal described this syndrome in 1935, extensive research was conducted linking PCOS and systemic ailments, such as type 2 diabetes mellitus and cardiovascular diseases [16]. A chronic inflammatory state due to insulin resistance and hyperinsulinemia has been observed in patients with PCOS. Hence, females with PCOS demonstrate higher serum levels of CRP, TNF-α, and IL-6 compared to those individuals who are healthy [17].

Gingivitis and periodontitis are common chronic inflammatory conditions caused by periodontopathic bacteria and are associated with elevated levels of systemic and local proinflammatory cytokines, such as CRP, TNF-α, IL-1, and IL-6 [13,18]. This increased concentration of proinflammatory mediators contributes to insulin resistance and creates chronic inflammatory conditions [14]. A common pathophysiological pathway connecting these disorders might exist because both PCOS and periodontal disease are associated with systemic inflammation and insulin resistance. It can be hypothesized that increased levels of proinflammatory cytokines due to low-grade chronic inflammation in PCOS may increase the incidence of periodontal disease and that elevated levels of proinflammatory cytokines in chronic periodontitis might further contribute to insulin resistance in patients with PCOS.

However, very few studies have focused on periodontal parameters in women with PCOS. This cross-sectional study aimed to compare the prevalence of periodontal disease between women with PCOS and healthy women.

A total of 196 women (98 per group in the PCOS and healthy groups) aged 17 to 45 years participated in this cross-sectional study. OHI-S, GI, CPI, and LA scores were recorded for all participants. The Student *t*-test was used to analyze the data.

The results showed that the study groups were adjusted for age ($p = 0.740$). Despite similar plaque scores ($p = 0.977$), women with PCOS had significantly higher GI scores than those who were healthy ($p < 0.001$). These findings agree with those of an earlier study [19] that also showed increased gingival inflammation in the PCOS group. This effect may be attributed to endocrinological changes, such as increased levels of testosterone, epiandrostenedione, luteinizing hormone, and estrogen [20]. It is well documented that estrogen promotes the growth of periodontal pathogens, especially *Prevotella intermedia*, increases cellular proliferation in blood vessels, and decreases keratinization [21] which may have contributed to the increased gingival inflammation in the PCOS group.

This study also showed that the CPI and LA scores were higher in the PCOS group than in the healthy group ($p < 0.001$). Our findings are in accordance with those of earlier studies [22,23], which demonstrated that patients with PCOS had increased pocket depth, clinical attachment loss, and bleeding sites on probing. In contrast to the present study, Isik et al. [24] demonstrated no significant difference ($p > 0.05$) in periodontal parameters, GI, percentage of bleeding on probing, and clinical attachment level (except for increased probing depth) in subjects with PCOS compared to healthy women. That study only included women of early

reproductive age and those recently diagnosed with PCOS; the periodontal examination was also performed only on the Ramfjord teeth. These selection criteria may have been critical to the observed disparity in the results [24].

The increased vulnerability of patients with PCOS to periodontal disease can be explained by the following mechanisms: (1) increased CRP levels; (2) elevated levels of proinflammatory chemokines and cytokines such as IL-17 [25], IL-18, IL-6, TNF-α, macrophage inflammatory protein-1, and monocyte chemoattractant protein-1; (3) substantial increases in the levels of monocytes and lymphocytes [26-28]; (4) abnormal endothelial function and marked elevation of numerous markers of endothelial inflammation such as soluble intercellular adhesion molecule-1, endothelin-1, plasminogen activator inhibitor-1, soluble vascular cell adhesion molecule-1, and asymmetric dimethylarginine [26,29,30]; (5) increased oxidative stress [26,31,32]; (6) reduced glutathione, and decreased levels of haptoglobin, a protein with antioxidant properties, hence resulting in low total antioxidant status [26,33,34]; and (7) elevated levels of advanced glycation end-products [26,35,36]. However, longitudinal studies with larger sample sizes are required to confirm this interpretation.

This study had certain limitations as body mass index (BMI), waist circumference, waist-to-hip ratio, and metabolic parameters were not assessed. The PCOS population has a higher prevalence of abdominal fat than individuals matched for weight [37]. Additionally, there is increased production of proinflammatory cytokines due to this fat [38], which increases the systemic inflammatory load that in turn enhances the initiation and progression of periodontal diseases.

Within the limitations of this study, women with PCOS had a higher prevalence of periodontitis than women who were healthy. There appears to be an interaction between PCOS and periodontitis that may have a synergistic effect on the production of proinflammatory mediators. Hence, education on periodontal health, early detection, and intervention for periodontal diseases are of paramount importance in patients with PCOS to maintain both periodontal and systemic health. Long-term studies are needed to elucidate the relationship between PCOS and periodontal disease. Future studies should include parameters such as waist-to-hip ratio, waist circumference, and BMI and should evaluate the effects of different drugs and periodontal therapies on patients with PCOS.

Notes

Conflicts of interest

Ramanarayana Boyapati has been editorial board member of *Journal of Yeungnam Medical Science* since 2022. He was not involved in the review process of this manuscript. There are no other conflicts of interest to declare.

Funding

None.

Author contributions

Conceptualization: SP, PKY, SJN, RB; Data curation: SP, SJN, NVKG; Formal analysis: SP, SJN; Investigation: SP, PKY; Methodology: SP, TKD; Project administration: SP; Resources: SP, RB; Software: SJN; Visualization: SP; Writing-original draft: SP; Writing-review & editing: SP, PKY.

ORCID

Sandhya Pavankumar, https://orcid.org/0000-0002-1669-3572
Pavan Kumar Yellarthi, https://orcid.org/0009-0002-7851-6616
Sandeep JN, https://orcid.org/0009-0001-0712-3375
Ramanarayana Boyapati, https://orcid.org/0000-0002-9196-0183
Trinath Kishore Damera, https://orcid.org/0000-0003-4657-0677
Naveen Vital Kumar G, https://orcid.org/0009-0008-5529-7418

References

1. Sheehan MT. Polycystic ovarian syndrome: diagnosis and management. Clin Med Res 2004;2:13–27.
2. Knochenhauer ES, Key TJ, Kahsar-Miller M, Waggoner W, Boots LR, Azziz R. Prevalence of the polycystic ovary syndrome in unselected black and white women of the southeastern United States: a prospective study. J Clin Endocrinol Metab 1998;83:3078–82.
3. Rebar R, Judd HL, Yen SS, Rakoff J, Vandenberg G, Naftolin F. Characterization of the inappropriate gonadotropin secretion in polycystic ovary syndrome. J Clin Invest 1976;57:1320–9.
4. Gambineri A, Pelusi C, Vicennati V, Pagotto U, Pasquali R. Obesity and the polycystic ovary syndrome. Int J Obes Relat Metab Disord 2002;26:883–96.
5. Ovalle F, Azziz R. Insulin resistance, polycystic ovary syndrome, and type 2 diabetes mellitus. Fertil Steril 2002;77:1095–105.
6. Wild RA. Long-term health consequences of PCOS. Hum Reprod Update 2002;8:231–41.
7. Franks S. Polycystic ovary syndrome. N Engl J Med 1995;333:853–61.
8. Kelly CC, Lyall H, Petrie JR, Gould GW, Connell JM, Sattar N. Low grade chronic inflammation in women with polycystic ovarian syndrome. J Clin Endocrinol Metab 2001;86:2453–5.
9. Yudkin JS, Stehouwer CD, Emeis JJ, Coppack SW. C-reactive

protein in healthy subjects: associations with obesity, insulin resistance, and endothelial dysfunction: a potential role for cytokines originating from adipose tissue? Arterioscler Thromb Vasc Biol 1999;19:972–8.
10. Festa A, D'Agostino R Jr, Howard G, Mykkänen L, Tracy RP, Haffner SM. Chronic subclinical inflammation as part of the insulin resistance syndrome: the Insulin Resistance Atherosclerosis Study (IRAS). Circulation 2000;102:42–7.
11. Watanabe K, Petro BJ, Shlimon AE, Unterman TG. Effect of periodontitis on insulin resistance and the onset of type 2 diabetes mellitus in Zucker diabetic fatty rats. J Periodontol 2008;79:1208–16.
12. Pitiphat W, Savetsilp W, Wara-Aswapati N. C-reactive protein associated with periodontitis in a Thai population. J Clin Periodontol 2008;35:120–5.
13. Loos BG, Craandijk J, Hoek FJ, Wertheim-van Dillen PM, van der Velden U. Elevation of systemic markers related to cardiovascular diseases in the peripheral blood of periodontitis patients. J Periodontol 2000;71:1528–34.
14. Reaven GM. Insulin resistance: the link between obesity and cardiovascular disease. Med Clin North Am 2011;95:875–92.
15. Soben Peter. Essentials of preventive and community dentistry. New Delhi: Arya Publishing House; 2000.
16. Mukherjee GG. Long-term health sequelae of polycystic ovary syndrome. In: Daftary S, Mukherjee GG, Vaidya R, editors. Polycystic ovary syndrome. New Delhi: Reed Elsevier India; 2010. p. 96–7.
17. Knebel B, Janssen OE, Hahn S, Jacob S, Gleich J, Kotzka J, et al. Increased low grade inflammatory serum markers in patients with Polycystic ovary syndrome (PCOS) and their relationship to PPARgamma gene variants. Exp Clin Endocrinol Diabetes 2008;116:481–6.
18. Özçaka Ö, Ceyhan BÖ, Akcali A, Biçakci N, Lappin DF, Buduneli N. Is there an interaction between polycystic ovary syndrome and gingival inflammation? J Periodontol 2012;83:1529–37.
19. Dursun E, Akalın FA, Güncü GN, Çınar N, Aksoy DY, Tözüm TF, et al. Periodontal disease in polycystic ovary syndrome. Fertil Steril 2011;95:320–3.
20. Padubidri VG, Daftary SN, Shaw W. Howkins & Bourne Shaw's textbook of gynaecology. 16th ed. New Delhi: Reed Elsever India; 2015.
21. Rose LF, Genco RJ, Mealey BL, Cohen DW. Periodontal medicine. Hamilton: B.C. Decker Inc.; 2000.
22. Porwal S, Tewari S, Sharma RK, Singhal SR, Narula SC. Periodontal status and high-sensitivity C-reactive protein levels in polycystic ovary syndrome with and without medical treatment. J Periodontol 2014;85:1380–9.
23. Rahiminejad ME, Moaddab A, Zaryoun H, Rabiee S, Moaddab A, Khodadoustan A. Comparison of prevalence of periodontal disease in women with polycystic ovary syndrome and healthy controls. Dent Res J (Isfahan) 2015;12:507–12.
24. Işık Y, Telatar GY, Neşelioğlu S, Biçer C, Gürlek B. Evaluation of periodontal status in different phenotypes of polycystic ovary syndrome in untreated patients of early reproductive age: a case-control study. J Obstet Gynaecol Res 2020;46:459–65.
25. Özçaka Ö, Buduneli N, Ceyhan BO, Akcali A, Hannah V, Nile C, et al. Is interleukin-17 involved in the interaction between polycystic ovary syndrome and gingival inflammation? J Periodontol 2013;84:1827–37.
26. Duleba AJ, Dokras A. Is PCOS an inflammatory process? Fertil Steril 2012;97:7–12.
27. Orio F Jr, Palomba S, Cascella T, Di Biase S, Manguso F, Tauchmanovà L, et al. The increase of leukocytes as a new putative marker of low-grade chronic inflammation and early cardiovascular risk in polycystic ovary syndrome. J Clin Endocrinol Metab 2005;90:2–5.
28. Herlihy AC, Kelly RE, Hogan JL, O'Connor N, Farah N, Turner MJ. Polycystic ovary syndrome and the peripheral blood white cell count. J Obstet Gynaecol 2011;31:242–4.
29. Orio F Jr, Palomba S, Cascella T, De Simone B, Di Biase S, Russo T, et al. Early impairment of endothelial structure and function in young normal-weight women with polycystic ovary syndrome. J Clin Endocrinol Metab 2004;89:4588–93.
30. Diamanti-Kandarakis E, Alexandraki K, Piperi C, Protogerou A, Katsikis I, Paterakis T, et al. Inflammatory and endothelial markers in women with polycystic ovary syndrome. Eur J Clin Invest 2006;36:691–7.
31. Sabuncu T, Vural H, Harma M, Harma M. Oxidative stress in polycystic ovary syndrome and its contribution to the risk of cardiovascular disease. Clin Biochem 2001;34:407–13.
32. Kuşçu NK, Var A. Oxidative stress but not endothelial dysfunction exists in non-obese, young group of patients with polycystic ovary syndrome. Acta Obstet Gynecol Scand 2009;88:612–7.
33. Fenkci V, Fenkci S, Yilmazer M, Serteser M. Decreased total antioxidant status and increased oxidative stress in women with polycystic ovary syndrome may contribute to the risk of cardiovascular disease. Fertil Steril 2003;80:123–7.
34. Dinger Y, Akcay T, Erdem T, Ilker Saygili E, Gundogdu S. DNA damage, DNA susceptibility to oxidation and glutathione level in women with polycystic ovary syndrome. Scand J Clin Lab Invest 2005;65:721–8.
35. Diamanti-Kandarakis E, Katsikis I, Piperi C, Kandaraki E, Piou-

ka A, Papavassiliou AG, et al. Increased serum advanced glycation end-products is a distinct finding in lean women with polycystic ovary syndrome (PCOS). Clin Endocrinol (Oxf) 2008; 69:634–41.
36. Diamanti-Kandarakis E, Piouka A, Livadas S, Piperi C, Katsikis I, Papavassiliou AG, et al. Anti-mullerian hormone is associated with advanced glycosylated end products in lean women with polycystic ovary syndrome. Eur J Endocrinol 2009;160:847–53.
37. Carmina E, Bucchieri S, Esposito A, Del Puente A, Mansueto P, Orio F, et al. Abdominal fat quantity and distribution in women with polycystic ovary syndrome and extent of its relation to insulin resistance. J Clin Endocrinol Metab 2007;92:2500–5.
38. Ruan H, Lodish HF. Insulin resistance in adipose tissue: direct and indirect effects of tumor necrosis factor-alpha. Cytokine Growth Factor Rev 2003;14:447–55.