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Exploring the Oral–Ocular Axis: An Observational Study on the Association between Chronic Periodontitis and Visual disturbances

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KEYWORDS

Chronic periodontitis, Visual acuity, Oral-ocular axis, Periodontal parameters, LogMAR, Systemic inflammation

ABSTRACT:

Introduction: Chronic periodontitis is a biofilm-associated, host-mediated inflammatory condition that damages tooth-supporting tissues and can exert systemic effects. Growing evidence indicates a link between periodontal inflammation and ocular diseases through systemic inflammation, bacteremia, and microvascular dysfunction. However, the impact of chronic periodontitis on visual function, particularly visual acuity, remains unclear.

Objectives: To assess the association between chronic generalized periodontitis and visual disturbances by comparing visual acuity in affected patients and periodontally healthy individuals.

Methods: A cross-sectional study was conducted among 80 participants (30–50 years), including 40 systemically healthy controls and 40 patients with chronic generalized periodontitis. Periodontal parameters-Plaque Index, Gingival Index, Probing Pocket Depth, and Clinical Attachment Level were recorded. Visual acuity was evaluated using Snellen's chart and converted to LogMAR units. Data were analyzed using chi-square, independent t-tests, and Pearson's correlation.

Results: Participants with periodontitis showed significantly reduced visual acuity compared to controls ($p < 0.01$). Mean LogMAR values and periodontal parameters were positively correlated, indicating that greater periodontal destruction was associated with poorer visual performance.

Conclusions: Patients with chronic generalized periodontitis exhibited significantly reduced visual acuity compared to periodontally healthy individuals, with deterioration correlating with greater periodontal destruction. These findings suggest a potential oral–ocular axis mediated by chronic inflammation and microvascular impairment. Future longitudinal and interventional studies are warranted to confirm causality and to evaluate whether periodontal therapy may improve or preserve visual function.

Introduction:

Chronic periodontitis is a biofilm-induced, host-mediated inflammatory disease that progressively destroys the supporting structures of the teeth.[1] While traditionally considered a localized oral condition, its chronic inflammatory burden and systemic dissemination of pathogenic bacteria or their by-products have been strongly implicated in extra-oral diseases.[2] Periodontal pathogens, such as *Porphyromonas gingivalis*, can induce transient

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bacteremia during routine activities like chewing and toothbrushing, triggering endothelial dysfunction, microvascular impairment, and systemic immune activation.[3]

The eye, a highly vascular and immune-privileged organ, is susceptible to systemic inflammatory mediators and microvascular changes. Disruption of the blood–ocular barriers has been reported in systemic inflammatory conditions, and periodontal inflammation may represent a previously underestimated contributor.[4] Epidemiological evidence supports this link: a nationwide Taiwanese cohort found that patients with periodontitis had a significantly higher risk of developing primary open-angle glaucoma, with an adjusted hazard ratio of 1.26, suggesting a possible chronic inflammatory or vascular pathway [5].

Beyond glaucoma, other ocular effects have been associated with periodontitis, including increased prevalence and severity of dry eye disease, ocular surface inflammation, and infectious ocular conditions. A recent cross-sectional study showed that patients with both periodontitis and dry eye disease exhibited higher tear osmolarity, reduced tear film stability, and elevated systemic inflammatory indices compared to controls [6]. Furthermore, experimental and clinical studies have documented that effective periodontal therapy can reduce markers of ocular inflammation such as aqueous flare, reinforcing the plausibility of a causal relationship [7].

Despite these emerging connections, there remains a paucity of research directly assessing **functional visual outcomes** in periodontitis patients. Visual acuity, a core measure of ocular function, has not been systematically evaluated in this population. This is a critical gap because even subtle reductions in acuity can impair daily activities and quality of life, and may indicate early ocular or neurovascular compromise.

Therefore, the present observational study aims to systematically assess visual acuity in patients with chronic periodontitis and explore whether a measurable association exists between periodontal disease severity and visual disturbances. Clarifying this relationship may uncover a novel systemic dimension of periodontitis, strengthen the concept of an oral–ocular axis, and inform the need for interdisciplinary screening protocols.

Objectives:

1. To record baseline visual acuity in individuals with clinically healthy periodontium.
2. To record baseline visual acuity in patients diagnosed with chronic generalized periodontitis.
3. To compare visual acuity findings between the two groups to identify any statistically significant differences.
4. To correlate visual acuity scores with periodontal parameters, including Plaque Index (PI), Gingival Index (GI), Probing Pocket Depth (PPD), and Clinical Attachment Level (CAL), in periodontitis patients.
5. To determine whether chronic generalized periodontitis may be associated with alterations in visual performance.

Materials and Methods

The present study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (revised 2013) for medical research involving human participants. Approval for the study was obtained from the Institutional Ethical Committee of Sri Siddhartha Dental College, Tumkur, Karnataka, India (Approval No: SSDCHIEC/2023/74). All participants were informed about the study objectives, methodology, potential risks, and benefits, and written informed consent was obtained before enrolment.

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Study Design and Setting:

This was a clinical, comparative, cross-sectional study carried out over a period of six months in the Department of Periodontology, Sri Siddhartha Dental College, Tumkur, India. Subjects were recruited from the outpatient department using a convenience sampling technique.

Sample Size Determination:

A priori power analysis was performed using G*Power software (version 3.0.1, Franz Faul, Universität Kiel, Germany). With an assumed effect size (w) of 0.35, α-error probability of 0.05, power (1–β) of 0.80, and degrees of freedom of 2, the total required sample size was calculated to be 80 participants. This sample size provided 80% power to detect significant differences between groups.

Study subjects:

Eighty subjects were enrolled and divided equally into two groups:

- **Group A**: Periodontally healthy individuals (n = 40)
- **Group B**: Patients with chronic generalized periodontitis (n = 40)

Inclusion Criteria:

1. Age between 30 and 50 years.
2. No periodontal therapy within the last six months.
3. No history of ocular surgery or treatment.
4. Systemically healthy individuals.
5. No intake of antibiotics or vitamin supplements in the last six months.

Exclusion Criteria:

1. History of age-related macular degeneration, cataract, diabetic retinopathy, or glaucoma.
2. Presence of systemic diseases such as hypertension or psychiatric disorders.
3. Intake of drugs known to cause gingival hyperplasia.
4. Habitual smoking or alcohol consumption.
5. Age below 30 years or above 50 years.

Clinical Periodontal Examination:

All periodontal measurements were recorded by a single calibrated examiner to minimize bias. The following parameters were assessed for all participants:

- Plaque Index (PI) – Silness and Löe, 1964 [8].
- Gingival Index (GI) – Löe and Silness, 1963 [9].
- Probing Pocket Depth (PPD) – measured using a UNC-15 periodontal probe
- Clinical Attachment Level (CAL) – measured from the cementoenamel junction to the base of the pocket

Assessment of Visual Acuity:

Visual acuity assessment was performed for both right and left eyes using the Snellen's chart under standardized lighting conditions.

Participants were instructed to cover one eye at a time without applying pressure and read aloud the smallest line of letters they could discern clearly. The procedure was repeated for the other eye. Visual acuity was recorded as a fraction, where the numerator represents the testing distance (6 m) and the denominator indicates the smallest line read correctly. Any refractive correction regularly used by the participant was worn during testing. The method followed the guidelines outlined by Bailey and Lovie (1976) [10] and Ferris et al. (1982) [11].

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Snellen's Chart Description:

The Snellen's chart consists of optotypes (letters or symbols) arranged in rows of decreasing size, with a standard testing distance of 6 meters (20 feet). Each line corresponds to a specific visual acuity fraction, expressed as **6/x** in metric units or **20/x** in feet, where "x" represents the distance at which a person with normal vision can read the same line.

LogMAR Conversion:

In addition to conventional Snellen fractions, results were converted to LogMAR (Logarithm of the Minimum Angle of Resolution) values for statistical precision. The LogMAR scale offers a continuous numeric measure of visual acuity, reducing statistical bias associated with fractional scores. A LogMAR value of **0** corresponds to 6/6 (20/20) vision, while positive values indicate worse acuity and negative values indicate better than standard acuity.

LogMAR was calculated using the formula:

LogMAR=log10(Denominator/ Numerator)of snellen fraction

Both Snellen fractions and corresponding LogMAR values were recorded for each participant.

Data Collection Procedure:

1. Eligible participants were recruited and assigned to groups based on periodontal diagnosis.
2. Periodontal parameters (PI, GI, PPD, CAL) were recorded.
3. Visual acuity was assessed for each eye using Snellen's chart, and results were documented in both fractional and LogMAR formats.
4. All measurements were entered into a pre-designed proforma for analysis.

Statistical Analysis:

Data were analyzed using SPSS software (version XX, IBM Corp., Armonk, NY). Descriptive statistics were computed for all variables. The **Chi-square (χ^2) test** was used for comparing categorical variables between the groups, with a significance threshold set at $p < 0.05$. Correlation analysis between periodontal parameters and visual acuity scores was performed using Pearson's correlation coefficient.

Results:

Distribution of the subjects based on visual acuity left and right eye (snellen's value) :

The distribution of subjects based on visual acuity in the left eye (Snellen's value) demonstrated a statistically significant difference between the Healthy and Chronic Generalized Periodontitis (CGP) groups ($\chi^2 = 13.05$, $p = 0.011$) [Table 1]. In the Healthy group, 57.5% exhibited 20/20 vision compared to only 22.5% in the CGP group. Conversely, poorer visual acuity categories were more prevalent among CGP subjects, with 27.5% showing 20/30 vision, 5.0% showing 20/40 vision, and 7.5% presenting with 20/50 vision, compared to 10.0%, 2.5%, and 0% respectively in the Healthy group. These results indicate that individuals with CGP had a higher proportion of reduced visual acuity in the left eye compared to healthy controls.

Table 1: Distribution of the subjects based on visual acuity left eye (snellen's value)

Visual acuity left eye (snellen's value)		Groups		Total
		Healthy	CGP	
20/20	Count	23	9	32

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	%	57.5%	22.5%	40.0%
20/25	Count	12	15	27
	%	30.0%	37.5%	33.8%
20/30	Count	4	11	15
	%	10.0%	27.5%	18.8%
20/40	Count	1	2	3
	%	2.5%	5.0%	3.8%
20/50	Count	0	3	3
	%	0.0%	7.5%	3.8%
Total	Count	40	40	80
	%	100.0%	100.0%	100.0%
Chi-square value-13.05				
p value-0.011*				

*significant

The distribution of subjects according to visual acuity in the right eye (Snellen's value) revealed a statistically significant difference between the Healthy and Chronic Generalized Periodontitis (CGP) groups ($\chi^2 = 22.66$, $p = 0.001$) [Table 2]. In the Healthy group, 67.5% demonstrated 20/20 vision compared to only 22.5% in the CGP group. Poorer visual acuity was more frequent in the CGP group, with 35.0% exhibiting 20/30 vision, 12.5% showing 20/40 vision, and 5.0% presenting with 20/50 vision, in contrast to 5.0%, 2.5%, and 0% respectively in the Healthy group.

These findings indicate a greater prevalence of reduced right eye visual acuity among CGP subjects compared to healthy controls.

Table 2: Distribution of the subjects based on visual acuity right eye (snellen's value)

Visual acuity right eye (snellen's value)		**Groups**		**Total**
		Healthy	**CGP**	
20/20	Count	27	9	36
	%	67.5%	22.5%	45.0%
20/25	Count	10	10	20
	%	25.0%	25.0%	25.0%
20/30	Count	2	14	16

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	%	5.0%	35.0%	20.0%
20/40	Count	1	5	6
	%	2.5%	12.5%	7.5%
20/50	Count	0	2	2
	%	0.0%	5.0%	2.5%
Total	Count	40	40	80
	%	100.0%	100.0%	100.0%
Chi-square value-22.66				
p value-0.001*				

*significant

Comparison of the mean log mar value between the groups:

Comparison of mean LogMAR values between the Healthy and Chronic Generalized Periodontitis (CGP) groups using an independent sample t-test revealed statistically significant differences for both eyes [Table 3].

For the left eye, the Healthy group demonstrated a mean LogMAR value of 0.06 ± 0.07, whereas the CGP group showed a higher mean value of 0.13 ± 0.11, with a mean difference of –0.076 (p = 0.001). Similarly, for the right eye, the mean LogMAR value was 0.04 ± 0.07 in the Healthy group and 0.15 ± 0.11 in the CGP group, with a mean difference of –0.104 (p = 0.001). These findings indicate a statistically significant reduction in visual acuity among individuals with chronic generalized periodontitis compared to healthy controls.

Table 3: Comparison of the mean log mar value between the groups using independent sample t test

Log mar va	Groups	N	Minimum	Maximum	Mean	S.D	Mean dif	p value
Left Eye	Healthy	40	0.00	.30	0.06	0.07	-0.076	0.001*
	CGP	40	0.00	.40	0.13	0.11		
Right Eye	Healthy	40	0.00	.30	0.04	0.07	-0.104	0.001*
	CGP	40	0.00	.40	0.15	0.11		

*significant

Correlation between plaque index, gingival index, periodontal pocket depth with visual acuity (left and right) :

Pearson's correlation analysis [Table 4] revealed no statistically significant association between visual acuity (left or right eye) and plaque index, gingival index, or periodontal pocket depth in the Healthy group ($p > 0.05$ for all). In contrast, the Chronic Generalized Periodontitis (CGP) group showed significant positive correlations between

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reduced visual acuity and periodontal disease severity.

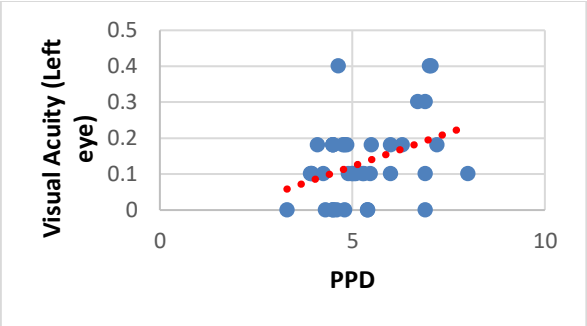
For the left eye, visual acuity correlated significantly with periodontal pocket depth (r = 0.374, p = 0.017) [Graph 1] and clinical attachment loss (CAL) (r = 0.401, p = 0.01) [Graph 2], while for the right eye, stronger correlations were observed with periodontal pocket depth (r = 0.570, p = 0.001) [Graph 3] and CAL (r = 0.594, p = 0.001) [Graph 4]. These results indicate that greater periodontal destruction, particularly increased pocket depth and attachment loss, is associated with poorer visual acuity in chronic generalized periodontitis patients.

Table 4: Pearson's correlation between plaque index, gingival index, periodontal pocket depth with visual acuity (left and right):

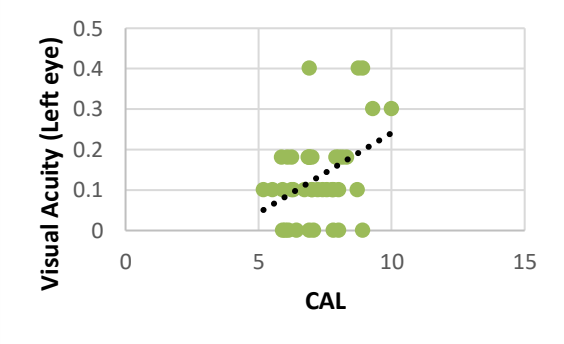
Groups	Side		Plaque Index	Gingival Index	Periodontal Pocket Depth	CAL
Healthy	Left	r value	-.044	-.015	.138	-
		p value	.786	.928	.395	-
	Right	r value	.088	-.156	.124	-
		p value	.589	.337	.444	-
CGP	Left	r value	.250	-.079	.374	0.401
		p value	.120	.628	.017*	0.01*
	Right	r val	.142	.235	.570	0.594
		ue				
		p value	.381	.144	.001*	0.001*

*significant

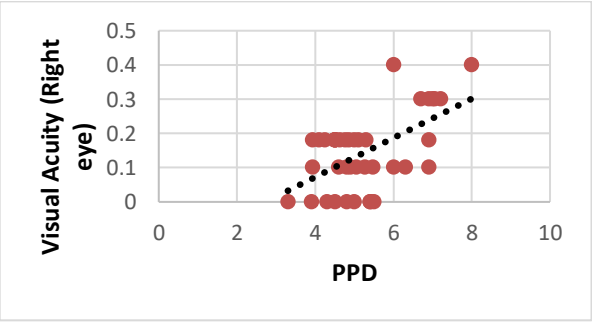
Graph 1: Correlation betwen PPD and Visual Acuity (Left eye):



Graph 2: Correlation betwen CAL and Visual Acuity (Left eye):



Graph 3: Correlation betwen PPD and Visual Acuity (Right eye):



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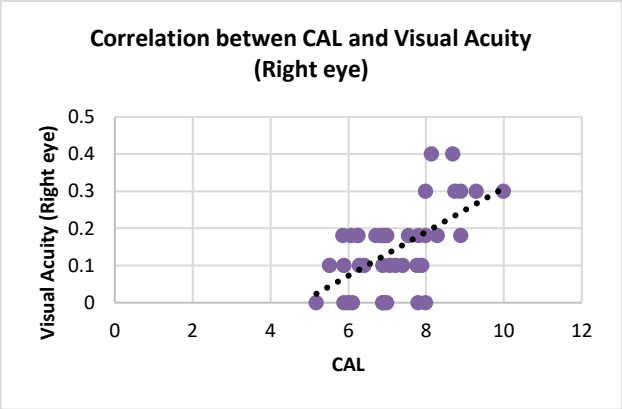
Graph 4: Correlation betwen CAL and Visual Acuity (Right eye):



Discussion:

To our knowledge, this is the first investigation directly comparing visual acuity between periodontally healthy individuals and those with chronic generalized periodontitis (CGP). Notably, both the left and right eyes of CGP subjects had significantly worse visual acuity—as expressed by higher LogMAR scores—when compared to healthy controls. Additionally, we observed strong positive correlations between visual impairment and periodontal disease severity, particularly with increased probing pocket depth (PPD) and elevated clinical attachment loss (CAL).

These findings are consistent with Tsai *et al.* (2022), who reported a higher prevalence of myopia among individuals with stage II/III periodontitis [12]. Our results also align with da Cunha *et al.* (2015), who documented that institutionalized individuals with significant visual impairment demonstrated deeper periodontal pockets and greater attachment loss [13]. Further, the systemic inflammatory hypothesis is supported by Sun *et al.* (2019), who linked periodontitis-associated elevation of inflammatory markers to heightened risk of ocular degenerative conditions such as AMD [14].

Chronic periodontitis involves sustained local inflammation, microbial translocation, and systemic immune activation. Elevated biomarkers—such as CRP and IL-6—can induce microvascular endothelial dysfunction, potentially impacting retinal circulation and optic nerve health. Additionally, shared mechanisms involving oxidative stress, complement system activation, and genetic predisposition could mediate the observed oral–ocular connection [15].

Our findings highlight the importance of integrated care approaches. Ophthalmic screening for visual dysfunction may benefit patients with advanced periodontitis, while periodontal management could play a preventative role in ocular health. Dental professionals should be aware of potential ocular sequelae and collaborate with ophthalmologists when warranted.

This study's strengths include its novel direct comparison of visual acuity between individuals with differing periodontal health statuses, the objective quantification of visual function using LogMAR in conjunction with comprehensive periodontal assessment, and the identification of dose-dependent relationships between periodontal parameters (PPD and CAL) and visual impairment. However, certain limitations must be acknowledged: the cross-sectional design precludes causal inference; the sample size, although sufficient to detect moderate effects, may limit generalizability; visual acuity was the sole ocular outcome measured, without inclusion of detailed ophthalmic evaluations such as retinal imaging or intraocular pressure assessment; and potential confounding factors, including refractive errors and underlying systemic conditions, were not fully controlled.

Prospective longitudinal studies, with comprehensive ophthalmic assessments and biomarker profiling, are needed to corroborate and clarify the temporal and mechanistic aspects of the oral–ocular axis. Interventional trials evaluating periodontal treatment outcomes on ocular health could reveal clinically actionable strategies.

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Conclusion:

The present study demonstrates a significant positive correlation between periodontal parameters, specifically periodontal pocket depth and clinical attachment level, and visual acuity impairment in both eyes. These findings suggest that periodontal disease severity may be associated with diminished visual function, supporting the concept of a potential bidirectional link between oral and ocular health. While the results highlight an important and underexplored association, longitudinal studies with larger, more diverse populations and comprehensive ophthalmic assessments are warranted to establish causality and further elucidate the underlying mechanisms

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