Section: Dentistry

Original Research Article

ROLE OF SALIVARY PH AND PERIODONTAL PARAMETERS IN PATIENTS WITH ORAL POTENTIALLY MALIGNANT DISORDERS

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ABSTRACT

Background: Oral potentially malignant disorders (OPMDs) are abnormalities of the oral mucosa that have been shown to be a risk factor for the development of oral cancer. The development and progression may be related to changes in saliva properties and chronic periodontal inflammation. The aim of this study was to evaluate salivary pH and periodontal parameters of OPMDs patients. **Materials and Methods:** This was a comparative cross sectional study carried out in the Rashid Latif Dental College, Lahore, during the period of January to June 2025. There were 82 participants enrolled and split into two groups: the OPMD group (41) and the control group (41). The unstimulated salivary pH was evaluated by a calibrated digital pH meter. Plaque Index, Gingival Index, bleeding on probing, probing pocket depth and clinical attachment loss were recorded. The associations were assessed by suitable comparative, correlation and multivariable regression analyses. **Results:** Mean salivary pH was significantly lower in the OPMD group than in controls (6.43 ± 0.48 versus 6.91 ± 0.42; $p<0.001$). Patients with OPMDs had significantly higher Plaque Index, Gingival Index, bleeding on probing, probing pocket depth and clinical attachment loss (all $p<0.001$). Salivary pH was inversely correlated with clinical attachment loss ($r=-0.48$; $p<0.001$) and other periodontal measurements. Salivary pH decreased progressively with increasing epithelial dysplasia severity ($p=0.002$). Acidic salivary pH (AOR=3.18; 95% CI: 1.18–8.56), smokeless-tobacco use (AOR=3.42; 95% CI: 1.15–10.20) and clinical attachment loss (AOR=1.84; 95% CI: 1.12–3.03) were independently associated with OPMDs. **Conclusion:** Patients with OPMDs exhibited greater salivary acidity and poorer periodontal health than controls. Salivary pH and periodontal assessment may provide useful supplementary information for the clinical evaluation and monitoring of these patients.

INTRODUCTION

Oral potentially malignant disorders are a heterogeneous group of oral mucosal changes that have a higher risk for developing oral squamous cell carcinoma. Oral leukoplakia, erythroplakia, oral submucous fibrosis and oral lichen planus are common OPMDs. They have a wide spectrum of clinical appearance, histopathological features and potential to become malignant. Early diagnosis and frequent surveillance is therefore critical to ensure lesions are diagnosed with more chance of progressing, and to minimize advanced oral cancer.[1-3]

Several behavioural, biological and environmental factors are involved in the development of OPMDs. The most commonly reported risk factors are tobacco smoking, smokeless-tobacco use, areca-nut consumption, betel-quid chewing, alcohol exposure, and nutritional deficiencies and chronic mucosal irritation. These exposures can leave a lasting damage to the epithelium, genetic changes, and oxidative stress. Smokeless tobacco consumption, such as gutka, naswar and pan and areca nut is a

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significant risk factor environment for OPMDs and oral cancer in South Asian populations.[4-6]

Saliva is fundamental in maintaining oral health as it lubricates, buffers, fights micro-organisms, remineralizes, and clears harmful substances. Salivary changes that alter flow, composition or pH may disrupt the oral microecological balance and decrease the protection of the oral mucosa. The acidic condition in saliva may contribute to the proliferation of microorganisms that are acid tolerant, to the production of oxidative stress, and to damage the epithelial barrier. This non-invasive, low-cost measurement of saliva pH is easily repeated and may be a useful additional marker to be used as an adjunct to oral examination. However, salivary diagnosis is not sufficient to make a diagnosis or determine the malignant nature of an oral lesion.[7-9]

Persistent microbial dysbiosis and chronic inflammation of the tooth-supporting tissues is the hallmark of periodontal disease. Cytokines, pro-teases and free radicals are released and contribute to plaque accumulation, gingivitis and periodontal pocket formation and clinical attachment loss. This inflammation could play a role in the mucosal injury and may interact with the biological mechanisms underlying epithelial dysplasia. Poor oral-hygiene habits and tobacco exposure are also risk factors for periodontal disease and OPMDs, requiring analysis of these factors as well as possible confounding factors.[10-12]

Although salivary alterations and periodontal inflammation have each been investigated in oral disease, limited evidence is available regarding their combined relationship with OPMDs and epithelial dysplasia in the local population. Evaluating these parameters together may improve understanding of the oral microenvironment associated with potentially malignant lesions and identify inexpensive measures that could supplement routine clinical assessment. Therefore, this study aimed to compare salivary pH and periodontal parameters between patients with and without OPMDs, determine their correlation and identify factors independently associated with the presence and histopathological severity of these disorders.

MATERIALS AND METHODS

A comparative cross-sectional study was conducted at the Department of Oral Medicine and Periodontology, Rashid Latif Dental College, Lahore, from January 2025 to June 2025. A total of 82 participants were enrolled through consecutive sampling and divided into two equal groups. The OPMD group included 41 patients with clinically diagnosed oral potentially malignant disorders, while the control group consisted of 41 individuals without any clinically detectable OPMD. Controls were recruited from patients attending the dental outpatient department for routine dental care and were selected to provide an approximately comparable age and sex distribution.

Patients aged 18 years or older, who had a clinical diagnosis of oral leukoplakia, oral submucous fibrosis, oral lichen planus, erythroplakia or any other known OPMD were eligible for inclusion in the OPMD group. The control group comprised adults who did not have an OPMD, oral cancer or any other active oral mucosal disease. Patients were excluded if they had previously had an oral squamous cell carcinoma, recurrent OPMDs, a history of chemotherapy or radiotherapy, acute oral infection, pregnancy, autoimmune salivary gland disease, or periodontal treatment in the last 6 months. Patients who were using drugs that are known to significantly affect saliva production such as anti-cholinergic drugs were also excluded. Age, sex, place of residence, educational status, oral hygiene habits, diabetes mellitus and tobacco habits were recorded in a structured proforma. The past and current habit of smoking, smokeless-tobacco, areca-nut or betel-quid use, and the number of times and length of time that one was exposed to each habit were recorded.

All the patients were examined orally, in a comprehensive manner, under proper illumination with clean dental instruments. The characteristics of the lesion, such as the type, location, dimensions, number, clinical appearance and duration, were documented in patients with OPMDs. The oral leukoplakia was divided into homogeneous and non-homogeneous, and other lesions were grouped based on the clinical characteristics. Incisional biopsies were taken in OPMD patients and samples were analyzed by a skilled oral pathologist when clinical evaluation so dictated. The disease classification was based on the histopathology, which was either absence of epithelial dysplasia or presence of mild, moderate or severe epithelial dysplasia. Periodontial assessment was carried out with UNC-15 periodontal probe at six sites around each tooth, except third molar. The following parameters were recorded: Plaque Index, Gingival Index, percentage of sites with bleeding on probing, probing pocket depth, gingival recession, clinical attachment loss, tooth mobility, number of missing teeth, furcation involvement. The periodontal condition was then categorized as periodontal health, gingivitis or periodontitis.

The unstimulated whole saliva was collected in the morning between 9:00 and 11:00 a.m. to reduce the effect of the circadian rhythm. The participants were told not to eat, drink, smoke, chew tobacco, brush their teeth with toothpaste or use mouthwash for at least 90 minutes prior to tasting. Each participant rinsed his mouth with plain water and then rested for about 10 minutes, after which they left the saliva to pool in the floor of the mouth for five minutes, and then spit it into a sterile, graduated container. Salivary flow rate was calculated by dividing the volume collected by the collection time and is expressed in mL/ min. Salivary pH was immediately measured at the time of collection using a calibrated

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digital pH meter. Standard buffer solutions were used to calibrate the instrument prior to each sample collection. Salivary pH was also studied as a continuous variable, and by categorising as acidic (<6.8), normal (6.8–7.2) or alkaline (>7.2). A periodontal examiner was trained prior to data collection, and repeated measurements were conducted for a sub-sample of the participants to ensure consistency.

Data were input and analyzed using IBM SPSS Statistics version 26.0. The Shapiro–Wilk test was used to assess the normality of continuous variables, and they were then presented as mean ± standard deviation or median with interquartile range. Categorical variables were displayed as frequencies and percentages. Normally-distributed continuous variables were compared between the OPMD group and the controls using the independent-samples t-test, while non-normally distributed continuous variables were compared between groups using the Mann–Whitney U test. The chi-square test or Fisher's exact test was used to compare categorical variables. All measurements of the saliva and periodontal fluid were compared between categories of epithelial dysplasia using one-way analysis of variance or the Kruskal–Wallis test. Pearlman or Spearman's correlation analysis was used to investigate correlations between the salivary pH and periodontal parameters. Independent factors associated with OPMDs after adjustment for age, sex, tobacco exposure, diabetes and periodontal findings were determined by multivariable binary logistic regression. Odds ratios with 95% confidence intervals were presented after adjustment and a two-tailed $P < 0.05$ was taken as statistically significant.

RESULTS

All participants (n = 82) included comprised 41 patients with OPMDs and 41 individuals without OPMDs. The average age of the subjects is 45.91 ± 11.62 years. Despite non-significant difference, patients in the OPMD group were slightly older than controls (47.63 ± 11.37 versus 44.20 ± 11.72 years; p=0.182). The proportion of males was 58.5% in the OPMD group and 51.2% in the control group (p=0.506). Patients with OPMDs were significantly more likely to currently use smokeless-tobacco than controls (46.3% vs. 19.5% p=0.010). Likewise, the OPMD group had significantly longer durations of tobacco use (p=0.004). There was no significant difference between the groups in terms of residence, frequency of toothbrushing or diabetes mellitus.

Table 1: Demographic and habit-related characteristics of the participants

Variable	OPMD group (n=41)	Control group (n=41)	p-value
Age, years	47.63 ± 11.37	44.20 ± 11.72	0.182
Male sex	24 (58.5%)	21 (51.2%)	0.506
Rural residence	23 (56.1%)	19 (46.3%)	0.378
Tobacco smoking	14 (34.1%)	7 (17.1%)	0.077
Smokeless-tobacco use	19 (46.3%)	8 (19.5%)	**0.010**
Areca-nut/betel-quid use	11 (26.8%)	4 (9.8%)	**0.046**
Habit duration, years	9.68 ± 6.17	5.47 ± 4.31	**0.004**
Brushing twice daily	9 (22.0%)	15 (36.6%)	0.147
Diabetes mellitus	7 (17.1%)	4 (9.8%)	0.334

Values are presented as mean ± standard deviation or frequency (percentage). OPMD: oral potentially malignant disorder.

Of the 41 patients who were diagnosed with OPMDs, the most common diagnosis was oral leukoplakia with 41.5% of patients. Among the patients, 29.3% had oral submucous fibrosis, 22.0% had oral lichen planus and 7.3% had erythroplakia. The most common site of involvement was the buccal mucosa. 36.6% of patients had no evidence of epithelial dysplasia, while 34.1%, 19.5% and 9.8% had mild, moderate, and severe dysplasia, respectively, as confirmed by histopathological examination.

Table 2: Clinical characteristics of patients with OPMDs

Characteristic	Frequency (%)
Type of OPMD	
Oral leukoplakia	17 (41.5%)
Oral submucous fibrosis	12 (29.3%)
Oral lichen planus	9 (22.0%)
Erythroplakia	3 (7.3%)
Anatomical site	
Buccal mucosa	19 (46.3%)
Tongue	9 (22.0%)
Gingiva/alveolar mucosa	6 (14.6%)
Floor of the mouth	4 (9.8%)
Lip or labial mucosa	3 (7.3%)
Histopathological grade	
No epithelial dysplasia	15 (36.6%)
Mild dysplasia	14 (34.1%)
Moderate dysplasia	8 (19.5%)
Severe dysplasia	4 (9.8%)

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Lesion duration, months, median (IQR)	14 (8–26)
Multiple lesions	8 (19.5%)

The mean salivary pH was significantly decreased in patients with OPMDs compared to controls (6.43 ± 0.48 versus 6.91 ± 0.42; p<0.001). The salivary pH was found to be less than 6.8 in 70.7% of the OPMD group and 31.7% of the controls (p<0.001). The mean unstimulated salivary flow rate (p=0.003) was also lower in patients with OPMDs. All of the measured periodontal parameters were inferior in the OPMD group. Those who had OPMDs had significantly higher mean Plaque Index and Gingival Index scores. Bleeding on probing, probing pocket depth and clinical attachment loss were also significantly greater in the OPMD group. Sixty-eight.3% of those with OPMDs had periodontitis, compared to 36.6% of controls (p=0.004).

Table 3: Comparison of salivary and periodontal parameters between the groups

Parameter	OPMD group (n=41)	Control group (n=41)	p-value
Salivary pH	6.43 ± 0.48	6.91 ± 0.42	**<0.001**
Acidic salivary pH (<6.8)	29 (70.7%)	13 (31.7%)	**<0.001**
Salivary flow rate, mL/min	0.31 ± 0.12	0.40 ± 0.14	**0.003**
Plaque Index	1.76 ± 0.55	1.29 ± 0.49	**<0.001**
Gingival Index	1.58 ± 0.51	1.15 ± 0.44	**<0.001**
Bleeding on probing, %	41.63 ± 16.84	27.46 ± 13.71	**<0.001**
Probing pocket depth, mm	3.61 ± 0.79	2.94 ± 0.64	**<0.001**
Clinical attachment loss, mm	3.28 ± 1.12	2.16 ± 0.91	**<0.001**
Missing teeth, median (IQR)	4 (2–6)	2 (1–4)	**0.008**
Periodontitis present	28 (68.3%)	15 (36.6%)	**0.004**

There were significant inverse correlations between salivary pH and the large-periodontal measurements. The salivary pH was associated with Plaque Index, Gingival Index, bleeding on probing, probing pocket depth, clinical attachment loss in the present study. Plaque Index, Gingival Index, bleeding on probing, probing pocket depth and clinical attachment loss were associated with lower salivary pH in the present study. The clinical attachment loss (r=−0.48; p<0.001) had the strongest inverse correlation with salivary pH. The results showed that as the saliva became more acidic the periodontal health worsened.

Table 4: Correlation between salivary pH and periodontal parameters

Periodontal parameter	Correlation coefficient (r)	p-value
Plaque Index	−0.39	**<0.001**
Gingival Index	−0.42	**<0.001**
Bleeding on probing	−0.44	**<0.001**
Probing pocket depth	−0.41	**<0.001**
Clinical attachment loss	−0.48	**<0.001**
Number of missing teeth	−0.29	**0.008**

Pearson's or Spearman's correlation was applied according to the distribution of each variable.

Mean pH of saliva decreased in a progressive manner as the severity of the histopathological lesions increased in the OPMD group. The mean pH for patients with epithelial dysplasia was 6.68 ± 0.38, whereas the pH was 6.45 ± 0.37 for patients with mild dysplasia and 6.10 ± 0.41 for patients with moderate or severe dysplasia (p=0.002). The percent of attachment loss and probing bleeding also significantly increased in these categories.

Table 5: Salivary and periodontal findings according to epithelial dysplasia severity

Parameter	No dysplasia (n=15)	Mild dysplasia (n=14)	Moderate/severe dysplasia (n=12)	p-value
Salivary pH	6.68 ± 0.38	6.45 ± 0.37	6.10 ± 0.41	**0.002**
Plaque Index	1.49 ± 0.47	1.78 ± 0.48	2.07 ± 0.55	**0.013**
Bleeding on probing, %	34.73 ± 13.59	41.29 ± 14.63	50.67 ± 17.41	**0.028**
Probing pocket depth, mm	3.18 ± 0.60	3.57 ± 0.67	4.18 ± 0.86	**0.004**
Clinical attachment loss, mm	2.67 ± 0.82	3.21 ± 0.87	4.12 ± 1.17	**0.001**

After adjustment for age, sex, tobacco use, diabetes and periodontal findings, salivary pH was an independent predictor of the presence of an OPMD in multivariable logistic regression. The odds of OPMD were around three times greater among participants with acidic salivary pH (adjusted odds ratio [AOR]=3.18; 95% confidence interval [CI]: 1.18–8.56; p=0.022). Smokeless-tobacco use and clinical attachment loss also were important independent variables.

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Table 6: Multivariable logistic regression of factors associated with OPMDs

Variable	AOR	95% CI	p-value
Acidic salivary pH (<6.8)	3.18	1.18–8.56	**0.022**
Smokeless-tobacco use	3.42	1.15–10.20	**0.027**
Clinical attachment loss, per 1-mm increase	1.84	1.12–3.03	**0.016**
Plaque Index, per one-unit increase	1.53	0.69–3.39	0.297
Age, per one-year increase	1.02	0.97–1.07	0.431
Male sex	1.31	0.45–3.81	0.619
Diabetes mellitus	1.47	0.36–5.99	0.592

AOR: adjusted odds ratio; CI: confidence interval.

Overall, patients with OPMDs exhibited a more acidic salivary environment and poorer periodontal health than individuals without these lesions. The progressive reduction in salivary pH and deterioration of periodontal measurements with increasing epithelial dysplasia suggest that salivary and periodontal assessments may provide useful supplementary information during the clinical evaluation of patients with OPMDs.

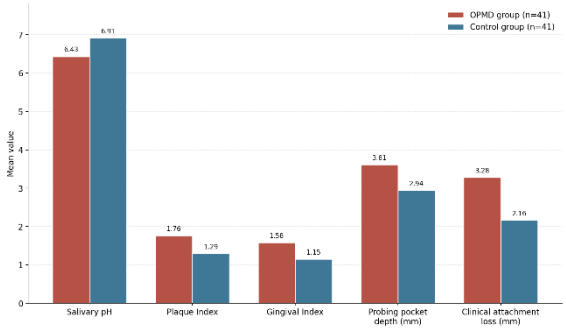

Figure 1: Comparison of mean salivary pH and periodontal parameters between patients with oral potentially malignant disorders (OPMDs) and controls. Patients with OPMDs demonstrated lower salivary pH but higher Plaque Index, Gingival Index, probing pocket depth and clinical attachment loss than controls

DISCUSSION

The present study evaluated the relationship of salivary pH and periodontal parameters with oral potentially malignant disorders among patients attending Rashid Latif Dental College, Lahore. Patients with OPMDs demonstrated a significantly lower mean salivary pH than controls, with acidic saliva being more frequent in the affected group. They also had significantly higher Plaque Index and Gingival Index scores, more bleeding on probing, deeper periodontal pockets and greater clinical attachment loss. These findings suggest that OPMDs are accompanied by alterations in the oral environment involving both salivary characteristics and periodontal health. The independent association of acidic salivary pH with OPMDs after adjustment for demographic, behavioural and periodontal factors further supports its possible clinical relevance.[13-15]

There is a lower salivary pH among patients with OPMDs, which can be attributed to several interacting mechanisms. Tobacco products, areca nut, betel quid and poor oral hygiene may impact the composition and buffering capacity of saliva and stimulate the growth of microorganisms that produce acids. Chronic mucosal inflammation can also have a negative impact on the function of the salivary glands and saliva's acid neutralizing capacity. An acidic oral environment can exacerbate oxidative stress, disrupt the oral microbial balance and compromise the protective properties of the oral mucosal epithelium. The present study was cross-sectional, however, it was not possible to determine if reduced salivary pH is a cause of OPMDs or a result of the lesion and the habits.[16,17]

The OPMD group had significantly poorer periodontal measurements suggesting a possible association between chronic periodontal inflammation and potentially malignant oral changes. The pockets allow for pathogen growth and exposure of bacterial products and inflammatory mediators over a prolonged period of time. Periodontal inflammation may result in the release of cytokines, tissue-degrading enzymes, and reactive oxygen species that could be involved in the impairment of the repair of the epithelium. The increased C.A.L. and BOP in OPMD patients could thus be a reflection of an inflammatory oral environment which may be conducive to the persistence or progression of oral lesions present in OPMD patients. However, periodontal disease should not be considered a direct cause of malignant transformation but as a potentially modifiable associated factor.[18]

As the epithelial dysplasia became more severe, there was a progressive decrease in the mean salivary pH and in the periodontal measurements. The probing pocket depth, clinical attachment loss and bleeding scores were the highest and the salivary pH was the lowest in the patients with moderate or severe dysplasia. Furthermore, the pH of saliva was negatively correlated with all major periodontal parameters, especially clinical attachment loss. The results of this study suggest that higher acidity of saliva is linked to increased periodontal destruction and more advanced histopathological changes. Measurement of pH in saliva is simple, non-invasive and inexpensive and, therefore, potentially a useful part of the clinical assessment. It cannot however, be used as a substitute for careful oral examination, biopsy or histopathological evaluation for diagnosis and grading of OPMDs.[19,20]

There are some limitations that should be taken into consideration when interpreting the findings. The study was carried out in one dental institution and involved a small sample size, which could constrain the extent to which the results could be generalized.

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This was because it could not be determined whether the cross-sectional design could be used to show changes in time and malignant transformation. Other factors that could influence the pH of saliva, such as dietary intake, hydration level, medications, systemic illness, and saliva collection time were standardized to minimize their effects. There could still have been residual confounding due to tobacco exposure and oral-hygiene behaviour. Further multicentre prospective trials with greater numbers of patients and repeated salivary pH measurements, microbiological analysis and long-term follow-up are recommended to establish if salivary pH and periodontal markers can predict lesion progression or malignancy.

CONCLUSION

Patients with oral potentially malignant disorders had significantly more acidic saliva and poorer periodontal health than individuals without these lesions. Lower salivary pH was associated with increased plaque accumulation, gingival inflammation, bleeding on probing, probing pocket depth and clinical attachment loss. Salivary acidity and periodontal deterioration also became more pronounced with increasing severity of epithelial dysplasia. Acidic salivary pH, smokeless-tobacco use and clinical attachment loss were independently associated with OPMDs. Salivary pH and periodontal assessment may therefore provide useful supplementary information during the evaluation and monitoring of affected patients, although histopathological examination remains essential for definitive diagnosis and grading.

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