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Original Research Article

Comparative Analysis of Salivary Porphyromonas gingivalis and Porphyromonas intermedia in Patients with Hypertension and Diabetes Mellitus

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Abstract: Oral health is an important part of maintaining overall systemic health. Current research demonstrates the intricate relationship between chronic systemic illnesses and the oral flora. Streptococcus mutans, Porphylomanas gingivalis, and Porphyromanas intermedia are the most prevalent oral pathogens associated with dental caries, but they have also been related to rheumatoid arthritis, diabetes mellitus, cardiovascular disease, and nervous system diseases. The purpose of this study was to count Porphylomanas gingivalis and Porphyromanas intermedia in saliva samples from people who had diabetes, hypertension, or both. This study discovered 71.8%, 74.3%, and 73.7% of patients with oral problems in diabetic, hypertension, and combined diabetes and hypertensive patients. There was a significant difference between diabetes ($p = 0.04711$), hypertensive ($p = 0.042155$), and diabetic and hypertensive ($p = 0.0483660$) persons with and without oral issues. There was no significant difference in porphylomanas gingivalis load in all groups (diabetic, hypertensive, and both diabetic and hypertensive patients) (p-value 0.970411), but there was a significant difference in porphylomanas intermedia load in all groups (diabetic, hypertensive, and both diabetic and hypertensive patients) (p-value: 0.000001). This study concluded that oral pathogens such as Porphyromanas gingivalis and Porphyromanas intermedia were more prevalent in patients with diabetes, hypertension, or both diabetes and hypertension. Thus, preventative treatment with oral care products is recommended to improve oral health in these people.

Keywords: Oral Health, Porphyromonas gingivalis, Porphyromonas intermedia, Diabetes Mellitus and Hypertension, Salivary Microbial Load.

INTRODUCTION

The oral microflora, also known as the oral microbiome, is made up of microorganisms such as bacteria, fungus, viruses, and protozoa that live in the mouth cavity. Depending on the ratio of helpful (good) to pathogenic (bad) species, these microorganisms can either be beneficial to oral health or cause disease. Beneficial oral bacteria help to stabilise biofilms, modulate immunological responses, and prevent pathogenic colonisation, all of which promote oral health1. Streptococcus salivarius generates bacteriocins, which kill dangerous bacteria like S. pyogenes. Streptococcus mitis functions as a commensal competitor and aids in immunological control. Streptococcus sanguinis produces hydrogen peroxide and helps to maintain a stable biofilm, lowering the incidence of dental caries. Veillonella species eat lactate produced by other bacteria, reducing acidity and preventing cavities1,2. Lactobacillus species suppress pathogenic germs and aid in maintaining oral pH by turning carbohydrates into less damaging acids. Pathogenic bacteria harm oral health and play an important role in the development of dental caries, gingivitis, and periodontitis. Streptococcus mutans contributes to dental cavities by producing acid and adhering to enamel via glucans. Porphyromonas gingivalis, a prominent periodontal infection, generates gingipains, which damage host tissues and bypass immune defences. Treponema denticola is related with advanced periodontitis and destroys tissue via proteolytic enzymes. Fusobacterium nucleatum promotes biofilm development by linking early and late colonisers, and it has been linked to

gingivitis and periodontal disease1,3.

Candida albicans is the cause of oral candidiasis, denture stomatitis, and opportunistic systemic infections in immunocompromised people. Porphyromonas intermedia (P. intermedia), a Gram-negative anaerobic periodontal bacterium, causes periodontitis and has been linked to systemic illnesses such diabetes mellitus (DM) and cardiovascular disease (CVD)4. Chronic infection with P. intermedia causes systemic inflammation and immune dysregulation, leading to endothelial dysfunction and atherogenesis through the induction of pro-inflammatory cytokines (e.g., TNF-α, IL-6) and elevated C-reactive protein levels (CRP)2,4.

These inflammatory activities promote lipid oxidation, foam cell production, and plaque instability, hence raising the risk of myocardial infarction and stroke. In DM, P. intermedia-induced inflammatory mediators interfere with insulin signalling, worsening insulin resistance and poor glycaemic management, whereas hyperglycemia promotes bacterial colonisation and periodontal vulnerability, resulting in a bidirectional pathogenic loop. P. intermedia-associated dyslipidaemia also adds to proatherogenic lipid profiles, linking periodontal infection to metabolic and cardiovascular problems, emphasising the importance of managing periodontal and systemic disorders together5.

This study was motivated by the desire to better understand the relationship between systemic diseases (diabetes and hypertension) and the prevalence of key periodontal pathogens, as well as to compare the microbial load of P. gingivalis and P. intermedia in people with these systemic conditions versus those without oral problems6,7. The study's primary goal is to assess and compare salivary porphyromonas gingivalis and porphyromonas intermedia loads in patients with diabetes, hypertension, or both. The goals are to examine oral health concerns (halitosis, xerostomia, and dental caries) as well as quantify and compare salivary Porphyromonas gingivalis and Porphyromonas intermedia levels in individuals with diabetes mellitus, hypertension, and their coexistence2,8,9.

MATERIALS AND METHODS:

The case-control observational study lasted six months, with a three-month study period, and included three main groups: diabetic patients (D), hypertensive patients (H), and patients with both diabetes and hypertension (DH), further subdivided into those with oral problems (D1, H1, DH1) and those without oral problems (D2, H2, DH2). Participants aged 30-65 years old with natural teeth who were willing to provide saliva samples were included, but those with recent antibiotic use, severe periodontal disease, active oral infections, pregnancy or lactation, recent dental procedures, systemic illnesses, heavy smoking or alcohol use, probiotic use, or special diets were excluded. The drooling method was used to gather unstimulated saliva samples into sterile containers over the course of 2-5 minutes. Porphyromonas gingivalis was detected using the colony count method based on typical colony morphology on selective agar media and validated microscopically. The data collected were subjected to suitable statistical analysis to find significant differences between the research groups.

RESULTS

The study included 438 patients, including diabetic (D, n = 153), hypertensive (H, n = 148), and diabetic-hypertensive (DH, n = 137). Among diabetes individuals, 110 (71.8%) had oral difficulties, while 43 (28.1%) had no issues. In the hypertensive group, 110 patients (74.3%) experienced oral difficulties, while 38 (25.6%) were free of them. Similarly, 101 (73.7%) diabetic-hypertensive patients had oral issues, compared to 36 (26.2%) who did not. Age-wise study of patients with oral disorders (D1, H1, and DH1) revealed a statistically significant difference between the groups (F = 3.28, p = 0.042), demonstrating variance in age distribution across illness categories.

Table 1: Age wise distribution of study participant with diabetes mellitus, hypertension, and both diabetes mellitus and hypertension patients

Groups	Count	Sum	Average	Variance
D1	30	1194.12	39.804	2985.137
H1	30	284.19	9.473	346.8816
DH1	30	3563.5	118.7833	83949.36

Source of Variation	SS	df	MS	F	P-value	F crit

Between Groups	191064.5	2	95532.27	3.283596	0.04219	3.101296
Within Groups	2531160	87	29093.79			
Total	2722224	89				

*(ANOVA single factor method was used)

The prevalence of specific oral disorders is documented. In the diabetic group (D1), 20 patients had halitosis, 26 had dry mouth, and 18 had cavities. In the hypertension group (H1), 18 patients had halitosis, 21 had dry mouth, and 16 had cavities. Among diabetic-hypertensive patients (DH1), 19 patients had halitosis, 25 had dry mouth, and 16 had cavities, indicating a substantial burden of oral problems in all three groups. The mean salivary Porphyromonas gingivalis count was significantly higher in patients with oral problems compared to those without oral problems. In diabetic patients, the mean value was 39.80 ± 1.87 in D1 versus 18.02 ± 4.12 in D2 ($p = 0.047$). In hypertensive patients, the mean was 43.29 ± 1.32 in H1 compared to 16.70 ± 3.68 in H2 ($p = 0.042$). Similarly, in diabetic–hypertensive patients, DH1 showed a significantly higher mean count (42.61 ± 1.94) than DH2 (19.28 ± 2.67; $p = 0.048$) (Table 2).

Table 2: Statistical values of salivary Porphyromanas gingivalis in D1 and D2, H1 and H2, DH1, and DH2

Group	Mean ± SD	P value
D1	39.80 ± 1.87	0.04711
D2	18.02 ± 4.12	
H1	43.29 ± 1.32	0.042155
H2	16.70 ± 3.68	
DH1	42.61 ± 1.94	0.048366
DH2	19.28 ± 2.67	

Comparative analysis using single-factor ANOVA revealed no statistically significant difference in P. gingivalis load among D1, H1, and DH1 groups ($p = 0.970$). Pairwise comparisons also showed no significant differences between D1 and H1 ($p = 0.817$), H1 and DH1 ($p = 0.965$), or D1 and DH1 ($p = 0.848$)

The mean salivary Porphyromonas intermedia count was significantly elevated in patients with oral problems. In diabetics, D1 showed a mean of 30.96 ± 8.97 compared with 19.44 ± 5.97 in D2 ($p = 0.045$). In hypertensive patients, H1 had a mean of 8.75 ± 3.91, while H2 showed 4.28 ± 1.37 ($p = 0.044$). In diabetic–hypertensive patients, DH1 demonstrated a mean of 33.09 ± 9.18 compared to 19.56 ± 4.93 in DH2 ($p = 0.045$) (Table 3).

Table 3 Statistical values of salivary Porphyromanas intermedia in D1 and D2, H1 and H2, DH1, and DH2

Group	Mean ± SD	P value
D1	30.96±8.97	0.04516
D2	19.44 ± 5.97	
H1	8.75 ± 3.91	0.04413
H2	4.28 ± 1.37	
DH1	33.09 ± 9.18	

DH2	19.56 ± 4.93	0.04508

Single-factor ANOVA showed a statistically significant difference in P. intermedia load among D1, H1, and DH1 groups (p = 0.000001). Pairwise comparisons indicated significant differences between D1 and H1 (p = 0.000) and between H1 and DH1 (p = 0.000). However, no significant difference was observed between D1 and DH1 (p = 0.698) (Tables 4–6).

Table 4: Comparison of Porphyromonas intermedia load in D1,H1 and DH1

Groups	Count	Sum	Average	Variance
D1	30	928.65	30.955	443.3304
H1	30	262.45	8.748333	71.07035
DH1	30	992.72	33.09067	462.0594

Source of variance	SS	df	MS	F	P-Value	F crit
Between	10902.46	2	5451.232	16.74794	0.000001	3.101296
within	28317.34	87	325.4867			
Total	39219	89				

Table-5: Comparison of Porphyromonas intermedia load in D1 and H1

Groups	Count	Sum	Average	Variance		
D1	30	928.65	30.955	443.3304		
H1	30	262.45	8.748333	71.07035		
Source of variance	SS	df	MS	F	P-Value	F crit
Between	7397.041	1	7397.041	28.75984	0.00000	4.006873
Within Groups	14917.62	58	257.2004			
Total	22314.66	59				

Single-factor ANOVA revealed a statistically significant difference in Porphyromonas intermedia load between D1 and H1 groups (P = 0.0000).

Table 6: Comparison of Porphyromonas intermedia load in H1 and DH1

Groups	Count	Sum	Average	Variance		
H1	30	262.45	8.748333	71.07035		
DH1	30	992.72	33.09067	462.0594		
Source of variance	SS	df	MS	F	P-Value	F crit
Between	8888.238	1	8888.238	33.34362	0.00000	4.006873
Within Groups	15460.76	58	266.5649			
Total	24349	59				

(*ANOVA single factor method was used)

The Single-factor ANOVA revealed a statistically significant difference in Porphyromonas intermedia load between H1 and DH1 groups (P = 0.0000).

Overall, patients with oral difficulties had considerably greater salivary levels of Porphyromonas gingivalis and Porphyromonas intermedia than those without dental problems. While there was no substantial change in P. gingivalis load between disease groups, P. intermedia levels varied significantly, particularly across hypertensive and diabetic groups.

DISCUSSION:

The purpose of this study was to quantify and compare the salivary loads of Porphyromonas gingivalis and Porphyromonas intermedia in individuals with diabetes, hypertension, or both, as well as the existence of oral issues such as halitosis, dry mouth, and dental cavities. The findings clearly show a higher microbial load in people with systemic disorders, indicating a link between oral dysbiosis and chronic health issues. An age-based analysis indicated substantial disparities between groups, especially in the DH1 group, which had a higher average age. Although the ANOVA test confirmed this as statistically significant, the clinical relevance

is most likely due to cumulative exposure to systemic stress and oral neglect in older people—a notion supported by epidemiological trends reported by Qin H et al.,7 who found that periodontitis prevalence rises with age.

The data showed a high prevalence of oral problems among diabetic (71.8%), hypertensive (74.3%), and comorbid (73.7%) patients. This supports previous findings from Al-Maskari et al.,6 who reported increased oral complications among individuals with diabetes due to impaired immune responses, altered salivary flow, and glucose-mediated changes in oral tissues.

Halitosis and dry mouth were particularly notable among the diabetic-hypertensive group (DH1), suggesting a cumulative effect of both conditions on oral health. These results align with Agarwal et al., study3 who found that diabetic patients suffer more frequently from salivary gland dysfunction and associated symptoms.

The P. gingivalis salivary loads differed statistically significantly between patients with and without oral issues (e.g., D1 versus D2, H1 vs H2, DH1 vs DH2). Previous research has identified P. gingivalis as a major pathogen in periodontal disease (Shanker et al., study5). It can evade immune defences and cause persistent inflammation. However, in this investigation, while P. gingivalis was raised in diseased groups, the differences across systemic disease categories were not as significant, implying that its role may be more closely related to local oral health issues than to systemic pathology alone.

Conversely, P. intermedia showed a stronger and more consistent correlation with systemic health status and oral symptoms. The microbial load was significantly higher in D1, H1, and DH1 groups, indicating its higher sensitivity to systemic inflammatory changes. This observation is supported by Al-Maskari et al., study6, who emphasized P. intermedia's capability to amplify inflammation and thrive in polymicrobial biofilms, especially in immunocompromised states.

Our findings are consistent with those of Vangipurapu4 et al., study, who identified P. gingivalis and P. intermedia as red-complex organisms that cause tissue damage and biofilm stability in periodontal pockets. The microbial burden seen in this study is probably a result of P. intermedia's synergistic interactions with Fusobacterium nucleatum and other pathogens, as reported by Takahashi & Nyvad12. In systemic settings, Gibson et al.13 discovered connections with diabetes and atherosclerosis, while Dominy et al.,11 connected P. gingivalis to Alzheimer's disease through neuroinflammatory pathways. These results support our study's hypothesis that higher salivary loads of periodontal pathogens could be a sign of more widespread systemic dysregulation.

The importance of comprehensive oral-systemic health treatment is shown by this study. The idea that two chronic illnesses worsen oral microbial imbalance is supported by the increased bacterial counts in comorbid patients (DH1). The reciprocal relationship between oral and systemic health is reinforced by the correlation between oral dysbiosis and systemic inflammation, particularly through cytokines like TNF-α and IL-1β (Lalla & Papapanou10). The Regular screening for P. gingivalis and P. intermedia could be used as a preventive measure to detect at-risk individuals, particularly in patients with diabetes and hypertension. These results also support multidisciplinary treatment, in which dentists actively manage patients with long-term illnesses. These findings provide credence to the idea that changes in the oral microbiota are largely caused by systemic inflammation, immunological dysfunction, and metabolic disorders typical of chronic illnesses. As a result, the clinical care of individuals with diabetes and hypertension should incorporate frequent oral health surveillance. Optimised oral hygiene practices, antimicrobial treatments, diet control, and interdisciplinary cooperation between medical and dental specialists are examples of preventive and therapeutic approaches that may help reduce oral complications and possibly lessen the burden of systemic diseases. To clarify the temporal and causal connections between periodontal infections and systemic illnesses, more research using bigger, diverse cohorts and longitudinal study methods is necessary. Furthermore, new opportunities for the combined management of oral and systemic health may arise from the development of specific microbiome-modulating medications.

CONCLUSION:

The current study demonstrates a substantial link between chronic systemic illnesses, including diabetes mellitus and hypertension, and an increased prevalence of oral health issues such as halitosis, xerostomia, and tooth caries. Microbiological data demonstrated that Porphyromonas intermedia had a significantly larger salivary load in affected people, particularly those who presented with oral symptoms, but Porphyromonas gingivalis showed less variance among the study groups. Statistical studies also revealed that microbial dysbiosis was most severe in individuals with diabetes and hypertension, highlighting the combined effect of systemic illnesses on oral microbial imbalance.

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