Oral hygiene status of individuals with cardiovascular diseases and associated risk factors

Divya Shetty,[1] Mahima Dua,[2] Kiran Kumar,[3] Raghu Dhanapal,[3] Madhusudan Astekar,[4] Devi Charan Shetty[3]

Departments of [1]Orthodontics, I.T.S. Center for Dental Studies and Research, Muradnagar, Ghaziabad (U.P); [2]Oral and Maxillofacial Pathology and Microbiology, Inderprastha Dental College, Sahibabad, Ghaziabad (U.P); [3]Oral and Maxillofacial Pathology and Microbiology, I.T.S. Center for Dental Studies and Research, Muradnagar, Ghaziabad (U.P); [4]Oral and Maxillofacial Pathology and Microbiology, Pacific Dental College and Hospital, Debari, Udaipur, Rajasthan, India

Abstract

Dentist and oral health screening may be the latest weapon in identifying persons at risk of cardiovascular disease. Oral infections, specifically periodontitis, may confer independent risks for different systemic conditions. The risk factors associated with cardiovascular diseases also suggest that the relationship between periodontal disease and diabetes works in both ways. The aim of this study was to support and strengthen the association and relationship between oral hygiene status of individuals with cardiovascular diseases and its associated risk factors. A simple random sampling was carried out in 200 inhabitants of Western Utter Pradesh, India. An oral health visit and examination was made for an equal number of males and females of different age groups with cardiovascular diseases. Evaluation of the oral status was made by means of an oral hygiene index, community periodontal index of treatment needs and loss of attachment. Evaluation of oral status in patients with cardiovascular diseases and in the control group has shown a statistically significant low level of oral health in patients with cardiovascular diseases as compared to control. Prevalence of systemic diseases in different age groups significantly correlated with the prevalence of severe periodontal diseases. Treating gum disease may reduce the risk of heart disease and improve health outcomes for patients with periodontal disease and vascular heart problems.

Introduction

A report by the Surgeon General in America says that the mouth serves as *a mirror of health or disease,* acting as a sentinel or early warning system, and providing an accessible model to analyze other tissues and organs with certain pathologies.[1] Commensal and pathogenic bacteria co-exist and the mouth is, therefore, protected from the natural physical and chemical antibacterial host defenses in these bacterial communities.[2] The persistence of microbial communities is the basis for the growing evidence that oral bacteria contribute to systemic diseases, for example, cardiovascular disease (CVD). Oral infections may also play a role in the pathogenesis of many systemic diseases in ill or immunocompromised individuals, but also in those in good health.[3] Studies by Beck *et al.,*[4] Mattila *et al.*[5] and de Stefano[6] found that dental health was lower in CVD patients than in controls.

Epidemiological studies have shown that oral infections, specifically periodontitis, may confer independent risks for different systemic conditions[7] such as osteoporosis, diabetes mellitus, pulmonary infections, pre-term low-weight births and cardiovascular diseases.[8] Periodontal infections are able to cause indirect damage by releasing inflammatory mediators and eliciting different host-related reactions, such as monocyte hypersensitivity and different autoimmune responses.[9] Past research found almost one in four have a personal history of periodontal disease and higher levels of an inflammatory marker which has been present in inflamed, rupture-prone plaque in heart arteries/valves.[5]

These findings suggest that the dentist and oral health screening may be essential in order to identify persons at risk of cardiovascular disease.[10] In addition to the above risk factors, research has also shown an association between periodontal disease and diabetes, which in turn contributes to CVD. Periodontal diseases can have an adverse effect on the cardiovascular system by themselves through mediators.[9] Therefore, the purpose of this study was to provide evidence to support and strengthen the association and relationship between oral hygiene status of individuals with cardiovascular diseases and its associated risk factors.

Materials and Methods

A simple random sampling was made in 200 inhabitants of Western Uttar Pradesh, India. An oral health visit and examination was made for the following four age groups: 25-34, 35-44, 45-54 and 55-64 years old. The clinical study included an equal number of males and females with cardiovascular diseases (ischemic disease, hypertension II, diabetes mellitus with no smoking habit) and an equal number of subjects without any systemic diseases. After adjusting for age, social class, hypertension, education and smoking, World Health Organization (WHO) criteria were used to evaluate oral status using the following indices:

- level of oral hygiene by oral hygiene index - simplified (OHI-S);
- community periodontal index and treatment needs (CPITN);
- loss of attachment (LA).[11]

The results obtained were subjected to statistical analysis using analysis of variance (ANOVA). All the necessary computation for the statistics was evaluated on SPSS (Version 14) software.

Results

The highest prevalence of cardiovascular diseases along with associated risk factors was in the 55-64 year old age group of patients with CVD with diabetes (n=75, 49%), followed by patients with only CVD (n=51, 33%), and the lowest number of cardiovascular diseases along with associated risk factors was found in patients in the 45-54 year old age group with CVD with hypertension (n=20, 14.49%) (Figure 1).

The prevalence of only the risk factors,

Correspondence: Madhusudan Astekar, Department of Oral and Maxillofacial Pathology and Microbiology, Pacific Dental College and Hospital, Debari, Udaipur, Rajasthan – 313024, India.
Tel. +91.9413026974.
E-mail: madhu.tanu@gmail.com

Key words: oral health, dental health surveys, cardiovascular disease, oral hygiene index, community periodontal index of treatment needs, systemic diseases.

Conflict of interests: the authors declare no potential conflict of interests.

Received for publication: 28 April 2012.
Revision received: 30 July 2012.
Accepted for publication: 30 August 2012.

This work is licensed under a Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).

©Copyright D. Shetty et al., 2012
Licensee PAGEPress, Italy
Clinics and Practice 2012; 2:e86
doi:10.4081/cp.2012.e86

Non-commercial use only

which are associated with CVD in different age groups, was highest in the 55-64 year old age group of patients with only diabetes (n=60, 42.85%) followed by patients with hypertension (n=54, 38.57%). The lowest prevalence was found in patients with other systemic diseases (n=10, 16.39%) and these patients did not have any CVD (Table 1).

All patients in the survey had low and very low levels of oral hygiene. The status of oral hygiene as determined by the OHI-S index was the lowest in patients with CVD along with associated risk factors (3.45±0.8) as compared to the patients who had only diabetes or hypertension (2.2±0.4). However, the statistical correlation between them did not reach significance (Figure 2).

The incidence of periodontal diseases showed an increase in the 55-64 year old age group. The average number of sextants with deep pockets in patients with CVD along with associated risk factors was 0.3 compared to 0.13 in the control. A statistically significant difference was found between the lowest CPITN scores, reflecting the periodontal status, found in patients with CVD along with associated risk factors (0.3±1.2), the scores of patients who had only diabetes or hypertension (0.2±0.6) (P<0.05). The intensity of periodontal and systemic diseases showed an increase in the adult group. The evaluation of oral status in patients with CVD and the control group showed a statistically significant low level of oral health in patients with CVD as compared to control (Figure 3).

There was a statistically significant difference in degrading status of the periodontal tissue between the higher score of loss of attachment of more than 4.5 mm in the patients with CVD along with associated risk factors (1.70±1.37) and the scores of the patients who had only diabetes or hypertension (1.4±1.2) (P<0.001). This suggests that there was a significant correlation between the prevalence of systemic diseases in different age groups and the prevalence of severe periodontal diseases (Table 1).

Discussion

All patients in the survey had low and very low levels of oral hygiene in comparison to the control group. The subjects with CVD with diabetes had the lowest score of CPITN and Loss of Attachment as well as a very low score of OHI-S. The intensity of periodontal and systemic diseases has increased in individuals belonging to the older age group. The important systemic risk factor for CVD is diabetes. Diabetes is commonly associated with the periodontal diseases, with a constant increase in the prevalence from 30% to 40%.[12] Persistent poor glycemic control has been associated with the incidence and progression of diabetes-related complications, including gingivitis, periodontitis and alveolar bone loss.[13] Several mechanisms have been proposed to explain the increased susceptibility to periodontal diseases, including alterations in host response, sub gingival microflora, collagen metabolism, vascularity, gingival crevicular fluid and hereditary patterns.[14] Multiple pathophysiological mechanisms (compromised neutrophil function, decreased phagocytosis and leukotaxis) have also been implicated in the increased alveolar bone loss found in patients with diabetes.[15] Adults with diabetes who received ultrasonic scaling and curettage in combination with systemically administered doxycycline therapy demonstrated significant reductions in mean glycosylated hemoglobin A1c at three months, reaching differences of nearly 10% compared to pre-treatment values.[15] There is evidence to suggest that periodontitis-induced bacteremia will cause elevations in serum pro-inflammatory cytokines, leading to hyperlipidemia, and ultimately causing an insulin-resistance syndrome, contributing to the destruction of pancreatic beta cells.[16] Treating chronic periodontal infections is essential for managing diabetes.[15] The risk of

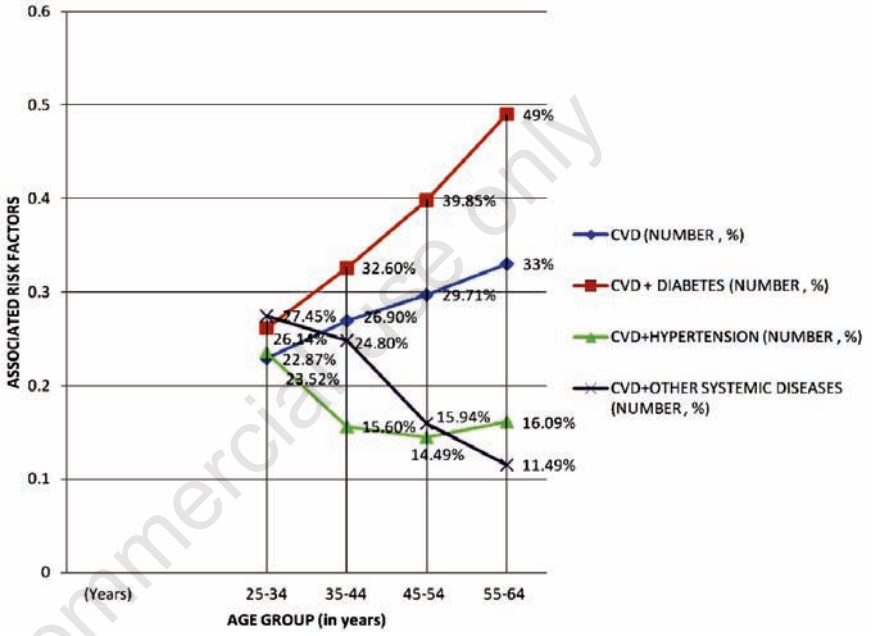


Figure 1. Prevalence of cardiovascular disease (CVD) patients in different age group in study population.

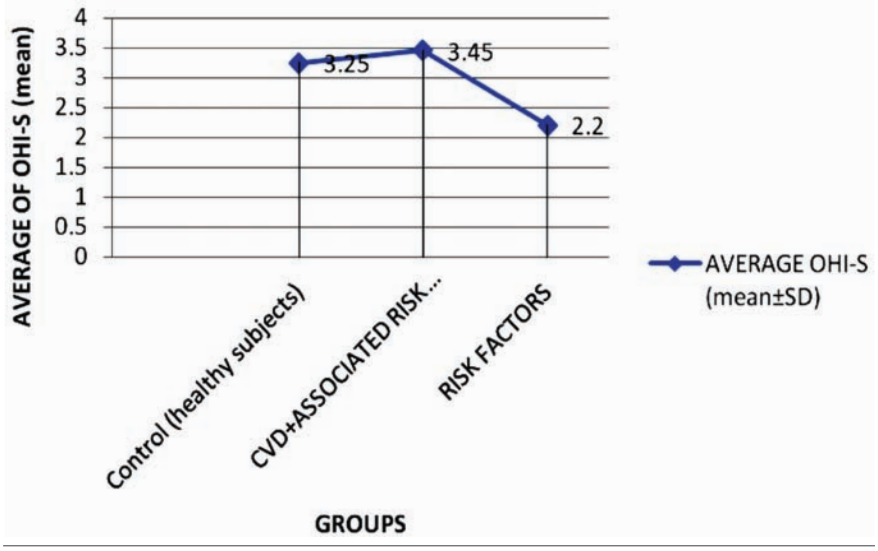


Figure 2. Dental evaluation in cardiovascular disease (CVD) patients along with associated risk factors. OHI-S, oral hygiene index simplified.

Non-commercial use only

development of CVD in diabetic patients increases by 2-4 times due to an increase in atherosclerosis in both the coronary arteries and the peripheral arteries.[17]

In the present study, subjects with CVD and hypertension had a low score of CPITN, Loss of Attachment and OHI-S. The levels of periodontal sub-gingival plaque are associated with prevalence of hypertension, which predisposes to severe CVD.[16] Six of the longitudinal studies suggested, that indicators of poor periodontal health precede cardiovascular events. De Stefano and colleagues analyzed data with 15-year epidemiological follow up.[5] They found that in 9760 men and women, periodontal disease was a significant predictor of subsequent coronary heart disease (CHD). Beck and colleagues found that high levels of alveolar bone loss at baseline (a measure of periodontal disease) were a significant predictor of total CHD incidence and stroke.[4]

Two studies have proposed that these associations are independent of age, sex, race, education, poverty index, marital status, blood pressure, serum cholesterol levels, diabetes status, body mass index and alcohol consumption. A study by Joshipura *et al.*[18] found that the association between self-reported history of periodontal disease and incidence of heart disease was no longer significant after adjusting for other risk factors. Danesh *et al.*[19] have recently demonstrated a weak association between heart disease and *Helicobacter pylori*.

However, there is considerable evidence from *in vitro* and animal models to support a plausible set of mechanisms by which *Cornebacterium pneumoniae* may contribute to heart disease.[19] Periodontal pathogens such as *Actinobacillus actinomycetemcomitans, B. forsythus, Prevotella gingivalis* and *Prevotella intermedia* may be present in arteriosclerotic plaques where they may play a role in the development and progression of atherosclerosis.[20] Monocyte-derived cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukins (IL-1, IL-6 and IL-8) may be released in response to a series of stimuli secondary to periodontal infection. One of these potential stimuli, the endotoxin lipopolysaccharide (LPS) may be present in subgingival plaque associated with periodontal disease. LPS and other bacterial components can activate an impressive cascade of inflammatory cytokines that, in turn, can play a role in arteriosclerotic heart disease, either through a direct action on the vessel wall or by inducing the liver to produce acute phase proteins.[21,22]

Another potential linking mechanism includes immune responses that result in production of antibodies to periodontal bacteria, including antibodies to bacterial heat-shock proteins that cross-react with heat-shock proteins of the heart. These auto-reactive antibodies to heat-shock proteins are found in patients with periodontal disease and may contribute to atheroma formation.[23,24] The clinical signs of periodontal disease are a result of infection with microorganisms interacting with the host's immune and inflammatory response; it is likely that including measurement of this interaction between infection and host response would have been a more direct measure of the exposure that we think of as periodontal disease.[20] Since the subjects in the study by Joshipura *et al.*,[18] responded to a *yes or no* question about periodontal disease, it is not possible to quantify its extent.

In addition, it is likely that subjects' self-reports of periodontal disease lead to misclassification.[20] Inconsistent findings serve as a warning that we should be conservative in making conclusions about causality. Differences in the way studies were conducted can bias the findings, especially when associations are moderate in degree. New studies are needed to explain the inconsistent findings;[20] most use new fatal and non-fatal myocardial infarction and hospitalization for cardiovascular procedures, some studies also include evidence of a *silent* or non-symptomatic myocardial infarction or a stroke. These different inclusion criteria for the outcome being studied may explain the differences in findings.[20] The studies that focused on stroke appear to demonstrate stronger relationships with periodontal disease than studies that used CHD as an outcome.

The second basic problem involves the variety of measures that have been used to describe the exposure (periodontal disease). One study used the total dental index, which is a combination of probing measures, furcation involvement and dental caries infections.[25] Three studies used Russell's non-probing periodontal index.[5,26,27] It is still not clear if periodontal disease actually causes heart disease. It is also not clear if treating gum disease can reduce the risks of heart disease and improve health outcomes for patients with periodontal disease and vascular heart problems. Results have been mixed, but research is still ongoing.[28] Patients with poorly controlled anti-hypertension will often bleed more after routine oral surgery. Patients who take hypertensive drugs may be more sensitive to the small amounts of epinephrine in dental anesthetics and may also need a greater level of assistance when being elevated in a dental chair from a supine (lying on the back) position. In periodontitis, bacteremia and/or endotoxemia may

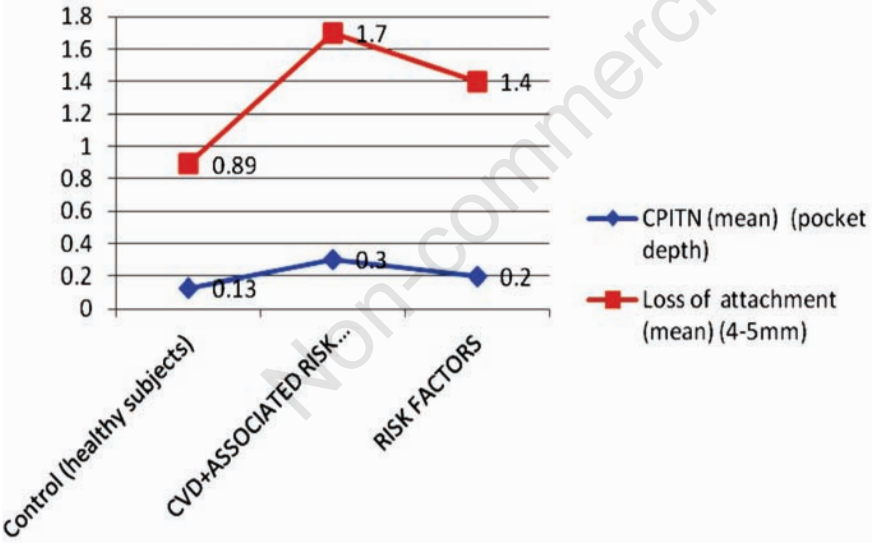


Figure 3. Evaluation of periodontal status in cardiovascular disease patients (CVD) along with associated risk factors. CPITN, community periodontal index and treatment needs.

Table 1. Prevalence of risk factors associated with cardiovascular disease according to different age groups.

Age range (years)	Number	Diabetes (%)	Hypertension (%)	Other systemic diseases (%)
25-34	61	27 (44.26)	24 (39.34)	10 (16.39)
35-44	75	34 (45.33)	28 (37.33)	13 (17.33)
45-54	99	42 (42.42)	36 (36.36)	21 (21.21)
55-64	140	60 (42.85)	54 (38.57)	26 (18.57)

Non-commercial use only

trigger a systemic inflammatory response that, in turn, may cause endothelial dysfunction and thus increase blood pressure and accelerate atherosclerosis. Endothelial dysfunction through the periodontal infection-inflammation pathway might be the link between periodontitis and hypertension. High consumption of potassium, possibly reducing the risk of hypertension, might decrease periodontitis severity and partially explain the association between periodontitis and hypertension.[29]

Conclusions

The oral hygiene status of individuals with cardiovascular diseases and associated risk factors was lower when compared to the control group. The strengths of the study included avoidance of examiner bias as the oral examination was performed by a single examiner who was blinded to other health examination data. In addition, to provide an adequate assessment of the severity of periodontitis, CPITN was used as recommended by the WHO. Further research on a larger sample size would be required to provide evidence to strengthen the association.

References

1. Rose LF, Mealey B, Minsk L, Cohen W. Oral care for patients with cardiovascular disease and stroke. J Am Dent Assoc 2002: 133:37S-47.
2. Socransky SS, Smith C, Haffajee AD. Subgingival microbial profiles in refractory periodontal disease. J Clin Periodontol 2002;29:260-8.
3. Meurman JH, Pyrhönen S, Lindqvist C. Oral sources of septicaemia in patients with malignancies. Oral Oncol Eur J Cancer 1997;33:389-97.
4. Beck J, Garcia J, Heiss G. Periodontal disease and cardiovascular disease. J Periodontol 1996;67:1123-37.
5. de Stefano F, Anda RF, Kahn HS. Dental disease and risk factor coronary heart disease. BMJ 1993;306:688-91.
6. Mattila KJ, Valtonen VV, Nieminen M, Huttunen JK. Dental infection and the risk of new coronary events: prospective study of patients with documented coronary artery disease. J Clin Infect Dis 1995;20: 588-92.
7. Renvert S. Destructive periodontal disease in relation to diabetes mellitus, cardiovascular disease, osteoporosis and respiratory disease. Oral Health Prev Dent 2003;1 Suppl 1:341-57.
8. Slavkin HC, Baum BJ. Relationship of dental and oral pathology to systemic illness. J Am Med Assoc 2000;284:1215-7.
9. Jukka H, Mariano Sanz MM, Sok-Ja Janket. Oral health, atherosclerosis, and cardiovascular disease. Crit Rev Oral Biol Med 2004;15:6:403-13.
10. Mager B. Presence of gum disease may help dentists and physicians identify those at increased risk for cardiovascular disease. New York-Presbyterian, November 25, 2008. Available from: http://nyp.org/news/hospital/gum-disease-cardiovascular.html
11. Glavind L, Loe H. Errors in the clinical assessment of periodontal destruction. J Period Res 1967;2:180-4.
12. Halter JB. Diabetes mellitus. In: Hazzard WR, ed. Principles of geriatric medicine and gerontology. 4th ed. New York: McGraw-Hill; 1999. pp 991-1011.
13. Ship J. Diabetes and oral health. An overview. J Am Dent Assoc 2003;134:4S-10S.
14. Taylor GW, Burt BA, Becker MP, et al. Glycemic control and alveolar bone loss progression in type 2 diabetes. Ann Periodontol 1998;3:30-9.
15. Grossi S. Treatment of periodontal disease and control of diabetes: an assessment of the evidence and need for future research. Ann Periodontol 2001;6:138-45.
16. Grossi SG, Skrepcinski FB, de Caro T. Treatment of periodontal disease in diabetics reduces glycated hemoglobin. J Periodontol 1997;68:713-9.
17. Iacopino AM. Periodontitis and diabetes interrelationships: role of inflammation. Ann Periodontol 2001;6:125-37.
18. Joshipura KJ, Rimm EB, Douglass CW, et al. Poor oral health and coronary heart disease. J Dent Res 1996;75:1631-6.
19. Danesh J, Collins R, Appleby P, Peto R. Association of fibrinogen, C-reactive protein, albumin, or leukocyte count with coronary heart disease: meta-analyses of prospective studies. J Am Med Assoc 1998; 279:1477-82.
20. Genco R, Offenbacher S, Beck J. Periodontal disease and cardiovascular disease: epidemiology and possible mechanisms. J Am Dent Assoc 2002;133 Suppl 1:14s-22s.
21. Castell JV, Andus T, Kunz D, Heinrich P. Interleukin-6: the major regulator of acute phase protein synthesis in man and rat. Ann N Y Acad Sci 1989;557:87-99.
22. Yamauchi-Takihara K, Ihara Y, Ogata A, et al. Hypoxic stress induces cardiac myocyte-derived interleukin-6. Circulation 1995;91:1520-4.
23. Wick G, Schett G, Amberger A, et al. Is atherosclerosis an immunologically mediated disease? Immunol Today 1995;16:27-33.
24. Sojar HT, Glurich I, Genco RJ. Heat shock protein 60-like molecule from bacteroides forsythus and porphyromonar gingivalis: molecular mimicry (abstract 275). J Dent Res 1998;77:666.
25. Mattila KJ, Valtonen VV, Nieminen M, Huttunen JK. Dental infection with the risk of new coronary events: prospective study of patients with documented coronary artery disease. Clin Infect Dis 1995; 20:588-92.
26. Wu T, Trevisan M, Genco RJ, et al. Periodontal disease and risk of cerebrovascular disease: the first National Health and Nutrition Examination Survey and its follow up study. Arch Intern Med 2000;160:2749-55.
27. Hujoel P, Drangsholt M, Spiekerman C, DeRouen T. Periodontal disease and coronary heart disease risk. J Am Med Assoc 2000;284:1406-10.
28. Genco RJ, Grossi SG, Zambon JJ, et al. Frequency of bacteremia following different modalities of periodontal treatment (abstract 842). J Dent Res 2001;80:141.
29. Yamori M, Njelekela M, Mtabaji J, et al. Hypertension, periodontal disease, and potassium intake in nonsmoking, nondrinker African women on no medication. Int J Hypertens 2011;2011:1-5.

Non-commercial use only