The Relationship between Oral Health Condition and Systemic Disease in Healthy Indonesian Population

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Abstract

Common diseases can be influenced by poor oral health. Inflammation is one major biological mechanism that links oral health condition and systemic disease. The purpose of this study was to investigate whether poor oral hygiene (OH), with or without the presence of periodontal disease, is significantly associated with biochemical markers of cardiovascular disease (CVD) in healthy Indonesian people. Methods: Ninety-eight subjects aged 52.1±8 (mean±SD) years participated in this cross-sectional study. The simplified oral hygiene index (OHIS) was used to measure OH. Blood samples were also taken to assess vascular inflammation by measuring high sensitivity C-reactive protein (hs-CRP), a biochemical marker of systemic disease and especially CVD. Multiple regression analyses were performed to analyze the association of hs-CRP and other risk variables, such as OHI-S, BMI, age, gender, and blood pressure. As a results, the OHI-S values for individuals with good OH and with poor OH were 1.52±1.9 and 5±3.1 mg/L, respectively. Subjects with poor oral hygiene had significantly higher CRP levels (p=0.0000) than those with good oral hygiene according to the Student's t-test. Poor OH was significantly associated with high levels of CRP after controlling for age, gender, BMI (body mass index), and blood pressure according to multiple regression analysis (β=0.29, p=0.007, R^2=0.2). It was concluded that this study suggests that poor oral hygiene may result in increased levels of CRP in a generally health population.

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Introduction

The possibility that infection in one part of the body can impact the health of other organs or tissues has been gaining increasing attention. The influence of periodontal infections on general health conditions has also captured the attention of the dental profession over the course of the past decade. Common diseases can be influenced by poor oral health, whether or not periodontal disease is present. Some researchers have found that periodontal disease is correlated with an increased risk of systemic disease, including diabetes mellitus and cardiovascular disease (CVD), as well as increased risk of heart attacks.[1] Other studies have concluded that gingival inflammation is associated with increased risk for stroke, and the results of these studies have emphasized the role of oral health in disease prevention.[2] In particular, bacterial inflammation has been argued to be the major biological mechanism that links oral health condition and systemic disease.

Good oral health and dental care can reduce the numbers of mostly facultative bacterial species that gain access to the bloodstream. However, poor oral hygiene can lead to greater numbers of bacteria colonizing the teeth and thereby influence local as well as systemic infections.[3] Therefore, the impact as well as the public awareness of dental disease on overall health is an important issue to study.

Some studies have found that individuals with periodontal disease have elevated serum

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levels of C-reactive protein, an inflammatory marker linked to increased risk for CVD. In addition, levels of high sensitivity C-reactive protein (hs-CRP) in the serum can be used to predict future cardiovascular events in healthy individuals.[4] Hs-CRP retains an independent association with incident coronary events even after adjusting for age, total cholesterol, HDL cholesterol, smoking, body mass index, diabetes, history of hypertension, exercise level, and family history of coronary disease.[5,6]

Many researchers have found a link between periodontal diseases and hs-CRP.[7,8] although other research groups have found no relationship and have concluded that oral health is a poor predictor of heart disease.[9-11] Furthermore, few data exist on conditions of oral hygiene (OH), with or without the presence of periodontal disease, in association with highly sensitive biochemical markers of systemic disease, especially CVD.

We investigated this issue in order to provide data that could increase the awareness of the impacts of oral hygiene and the possible complications of poor oral hygiene, with the ultimate goal of prolonging life in healthy Indonesian people.

The simplified oral hygiene index (OHI-S) was developed by Greene and Vermillion[12] for measuring oral hygiene and has proven to be a reliable instrument for large epidemiological studies. This index has been used to examine the role of oral debris in systemic disease. Oral debris could be a predisposing factor for inflammation in healthy individuals. Even so, several questions remain. For instance, how strong must the association between these variables be before this association can be considered clinically significant? Should the dental profession advocate for the prevention of periodontal diseases only to improve oral health or also to improve general health?

To answer these questions, research studies should address whether poor oral hygiene, with or without the presence of periodontal disease, can affect the prevalence or the incidence of systemic disease or increase the risk of disease, in comparison to good oral hygiene.

Therefore, the purpose of this study was to investigate whether poor oral hygiene, with or without the presence of periodontal disease, was significantly associated with biochemical markers of CVD (hs-CRP). We assessed risk factors for CVD such as OHI-S, BMI, age, gender, and blood pressure in a multiple regression analysis in order to identify the relationships among these factors.

Materials and methods

Subject sampling

Initially, 100 subjects took part in this study. Two were excluded from the analysis because they were edentulous. Thus, a total of 98 subjects who were not taking medication for CVD participated in this cross-sectional study. All subjects were Indonesian and in good general health and did not require special care to complete their daily activities. None of the subjects had history or current signs of CVD or had been hospitalized. The ethical review board of the Faculty of Dentistry, Universitas Indonesia, approved this study, and written informed consent was obtained from all subjects who participated in this study.

The simplified oral hygiene index (OHI-S) developed by Greene and Vermillion[12] was used to measure oral hygiene in the study participants. The debris and calculus indices were assessed on 6 index teeth. For each individual, 3 debris and 3 calculus scores were assessed for separate index teeth; these scores (ranging from 0–3) were totaled and divided by the number of teeth assessed. The OHI-S was then constructed by summarizing the debris and the calculus scores (range 0–6). Two dentists performed the oral examinations. Intra-examiner and inter-examiner calibrations were performed on patients prior to initiating the measurements.

Measurement of hs-CRP

Serum hs-CRP was measured in non-fasting subjects. To measure hs-CRP, venous blood was taken and analyzed by a clinical laboratory according to an immunometric assay using reagent latex beads (NA Latex CRP kit; Dade Behring). Traditional CRP methods lack the desired sensitivity and are unsuitable for the purpose of predicting future risk of coronary events in apparently healthy individuals.

This latex - enhanced immune nephelo metric hs-CRP method was recently evaluated and clinically validated.[13] Also, several automated immune turbid metric and immune

lumino metric hs-CRP assays have been recently developed and are commercially available. Researchers have reported that Dade Behring assays currently generate the best results for clinical and epidemiological applications.[14]

Statistical analysis

For analysis, OHI-S scores were dichotomized into 0 = good oral hygiene (OHI-S ≤ 1) and 1 = poor oral hygiene (OHI-S > 1). The mean and standard deviation of hs-CRP levels (mg/L) were calculated. The association between hs-CRP and poor OH or good OH was evaluated by the Student's t test. Multiple regression analyses were used to associate hs-CRP with potential risk variables such as OHI-S, BMI, age, gender, and blood pressure. The level of significance was set at $p<0.05$ for these tests. All calculations and statistical analyses were performed using SPSS 17 (Statistical Package for the Social Sciences) software.

Results

The characteristics of the 98 subjects, with an average age of 52.1 ± 8 years, are shown in Table 1.

	Males	Females
OHI-S		
good oral hygiene	5	11
poor oral hygiene	28	54
hs-CRP (mg/L)	4.4 ± 3.7	4.4 ± 3
Age (years)*	51.5 ± 8.6	52.3 ± 8.4
Systole (mmHg)*	161.6 ± 21.5	157 ± 20.6
Diastole (mmHg)*	83.6 ± 9	85.7 ± 9.1
BMI*	25.7 ± 3.5	25.3 ± 3.1

*All values are expressed as means ± standard deviations.

Table 1. Description of the study population.

The chi-square test and Student's t-test were used to compare measured variables when applicable. No significant differences were found between males and females in OHI-S, hs-CRP, age, and LDL cholesterol. Considering these findings, we did not divide the subjects based on gender.

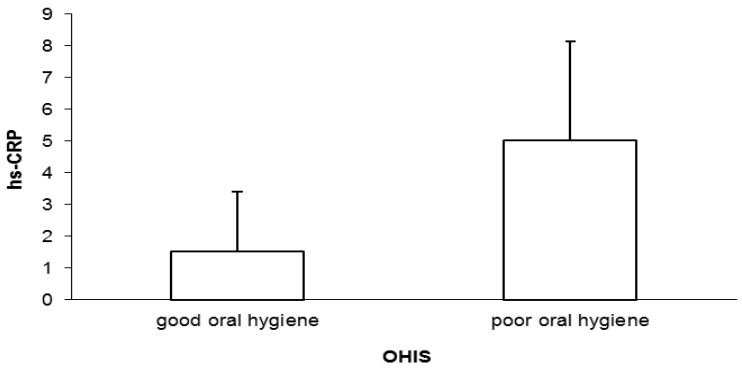

Figure 1. The relationship between high sensitivity C-reactive protein (hs-CRP) and the simplified oral hygiene index (OHI-S)

The relationships of the OHI-S score with good OH and with poor OH are shown in Figure 1. The mean and standard deviation values of the OHI-S scores for those with good OH and with poor OH were 1.52 ± 1.9 and 5 ± 3.1 mg/L, respectively. Subjects with poor oral hygiene had significantly higher hs-CRP levels in their serum (p=0.0000) than those with good oral hygiene according to the Student's t-test. The results of the logistical regression analysis are shown in Table 2. The hs-CRP levels were significantly associated with the OHI-S scores after controlling for age, BMI, gender, and systolic and diastolic blood pressure (β=0.29, R^2=0.2, p<0.05).

hs-CRP (mg/L)	Coefficient	Standard Error	Standardized coefficient	P-value
OHI-S (good OH [0]; poor OH [1])	2.51	0.9	0.29	0.007
Age (< 53 yo [0]; > 52 yo [1])	1.55	0.67	0.24	0.02
BMI (kg/m^2)	-0.03	0.09	-0.03	NS
Gender (male [0]; female [1])	2.11	0.87	0.08	NS
Systolic blood pressure	0.01	0.02	0.08	NS
Diastolic blood pressure	0.03	0.03	0.09	NS
Number of subjects				98
Coefficient of determination (R^2)				0.262

Table 2. Results of multiple regression considering high sensitivity C-reactive protein *hs-CRP) as the dependent variable.

Discussion

The results of our study demonstrated that hs-CRP was significantly associated with the oral hygiene condition of a generally healthy population (Figure 1). Subjects with poor OH showed higher hs-CRP mean values than those with good OH. According to the consensus conference of the American Heart Association and the Center for Disease Control, subjects with hs-CRP concentrations lower than 1 mg/L are considered to be at low risk, whereas those with concentrations in the 1–3 mg/L range are considered to be at medium risk. Those with serum hs-CRP concentrations greater than 3 mg/L are considered to be at high risk of future cardiovascular disease and events.[4] In this study, subjects with poor OH were placed into the category of high risk for future CVD.

Different studies have found evidence that links oral infection with an individual's susceptibility to systemic disease. The three main mechanisms or pathways of this increased risk are related to shared risk factors, the presence of subgingival biofilms that act as reservoirs of gram-negative bacteria, and the periodontium acting as a reservoir of inflammatory mediators.[13-15] The increased number of bacteria in subjects with poor OH possibly introduces more bacteria into tissues and the bloodstream, leading to an increase in the prevalence and magnitude of bacteremia. This finding is strengthened by previous studies that serum CRP levels are higher in periodontitis patients than in healthy subjects and are also higher in patients with more severe periodontitis.[16,17]

The multiple regression analysis showed that, of the examined factors, the OHI-S had the strongest positive correlation with hs-CRP (Table 2). To accurately diagnose CVD, clinical examination by experts is needed, and blood tests of biochemical markers of CVD are also useful. In general, diagnosis requires laboratory equipment and materials in addition to special expertise and can be relatively expensive. Meanwhile, OHI-S is a unique assessment in the field of clinical dentistry that currently is used to quantify periodontal disease in patients. This test could also potentially quantify the future risk of CVD. The ability of this index to simultaneously measure oral health and risk for

CVD could possibly facilitate a reduction in health care costs and improve the provision of health care. However, more findings are needed before informing patients that improving oral hygiene can prevent future heart attacks. Even so, a large number of cross-sectional and cohort studies have coincided in the findings of the present study and have found a link between oral health and systemic disease.

However, future research is needed on the interactions and the complex connections between oral health and inflammation in the vasculature. As research and technology continue to improve, well-designed studies can clarify these connections, although advising patients to improve oral health in order to prevent periodontal infections and their spread into the bloodstream appears to be sound advice from the perspective of professional dental practice. The objective measurement of oral hygiene condition could therefore improve an assessment of both dental and disease risk, which could also support more integral needs-based treatment plans.

Finally, the limitations of this study should be taken into consideration. Our study is cross sectional with a relatively small sample size. This may limit the interpretation of our findings. Further investigations with longitudinal study designs that consider larger populations are necessary to further confirm our findings.

In conclusion, our study suggests that poor oral hygiene may result in an increased risk of CVD based on serum hs-CRP levels in a generally healthy population.

Declaration of Interest

There are no conflicts of interest in this research.

Acknowledgements

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