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Correlation study on oral health and electrocardiogram abnormalities

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Abstract: The purpose of this study was to investigate the association between periodontal conditions and electrocardiogram test results that were obtained to screen for coronary heart disease risk factors. The present study included a total of 578 subjects who underwent annual medical check-ups at the Total Health Care Center in Otsu, Shiga Prefecture, Japan. To calculate the odds ratios for the electromyography abnormalities, we performed a logistic regression analysis for the oral examination, electrocardiogram, and blood analysis data. The crude odds ratio was obtained by a logistic regression analysis of age, sex, number of missing teeth, number of filled teeth, simplified oral hygiene index, community periodontal index, and blood analysis factors and results indicated there was a statistically significant correlation with the prevalence of electrocardiogram abnormalities. However, electrocardiogram abnormalities have a strong correlation with demographic factors such as sex and age. Therefore the experimental factors representing oral status were reexamined after the odds ratios were adjusted for age and sex. As a result of this adjustment, the new odds ratios that were determined indicated that there were no correlations between the oral factors and the prevalence of electrocardiogram abnormalities. (J. Oral Sci. 46, 241-246, 2004)

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Introduction

According to a survey by the Health and Welfare Statistics Association, the three major causes of death in Japan are cancer (31.0%), circulatory disease (15.3%) and cerebrovascular disease (13.6%) (1). The circulatory disease percentage is increasing and this disease is now a major cause of death of middle-aged subjects (1).

It has been reported that periodontal disease is a potent risk factor for coronary heart disease (2-10), and using *in vitro* studies, etiological bacteria of periodontal diseases have been found to invade aortic and heart endothelial cells (11,12). In addition, in epidemiological studies, some cross-sectional observations have shown a correlation between oral conditions and coronary heart disease (3,5,10,13). Also, some longitudinal studies have reported that periodontal disease is a potent risk factor for coronary heart disease (3,5,10). Unfortunately, the designs of these studies are inadequate. For example, sample sizes were insufficient, sampling methods for the study population may have contained some bias and adjustments for confounding factors were not carried out. In contrast, Hujoel *et al*. has reported that there is no correlation between periodontal conditions and coronary heart disease in longitudinal cohort studies (14,15). Therefore, the currently available evidence overall is not sufficient to be able to recognize periodontal disease as a risk factor for coronary heart disease (16,17).

Additionally, as the prevalence of risk factors varies from

country to country, the incidence of coronary heart disease also differs between nations (18-20). Obesity is a strong risk factor that has been documented for coronary heart disease (21,22). It is also well known that the American population is more obese than the Asian population. Thus the obesity conditions found for Japanese will be different from those seen for an American Caucasian population (23).

Circulatory disease diagnoses are usually made by evaluations of electrocardiograms, chest radiographs, echocardiographies, phonocardiograms, intracardiac catheters, coronary angiographies, myocardial scintigram test results, anamneses, and physical examinations. Among these, electrocardiograms are particularly used for the screening of coronary heart disease because of the accuracy and convenience. Electrocardiograms can be used to diagnose heart diseases such as arrhythmia, ventricle hypertrophy, myocardial infarction, angina pectoris, coronary heart disease, congenital coronal heart disease, cardiomyopathy, and chronic pulmonary disease.

Since periodontal disease and heart disease are common and a significant public health concern, the aim of our study was to investigate the association of periodontal conditions with coronary heart disease factors. Therefore, we investigated the correlation of oral status with heart disease by examining electrocardiogram abnormalities in a cross-sectional survey of the Japanese population.

Materials and Methods

Study population and sampling

The subjects investigated in this study all underwent annual medical check-ups at the Total Health Care Center from April 1995 to March 1996 in the city of Otsu in Shiga Prefecture, Japan. During this time period a total of 578 people (178 males, 400 females, age range 34 ~ 82 years old, mean 52.0 ± 10.1) underwent annual medical check-ups and all subjects were included in this study.

Oral examination

Oral examinations were carried out by a dentist under normal light and by using mirrors and a periodontal probe according to the methods of the WHO standard criteria.

The periodontal condition was checked by periodontal pocket depth, and evaluated by the community periodontal index (CPI). Oral hygiene was evaluated by the simplified oral hygiene index (OHI-S). Venous blood samples were obtained during medical check-ups and before analyses, the results of OHI-S were divided into four groups by the percentiles (-25, 25-50, 50-75, 75-).

Blood analysis

Blood analyses, blood pressures, anthropometrics measurements, were obtained in all subjects. Blood sampling was performed with the subjects in a seated position.

Electrocardiogram

Patients were placed in a supine position and electrocardiograms were performed using a 12-lead ECG and recorded by means of a standard electric cardiograph equipped with an automated analysis system. As seen in Table 1, we found 34 types of ECG abnormalities.

Statistical analysis

Before analysis, subjects were divided into two groups, those with and those without electrocardiogram abnormalities. A logistic regression analysis was used to calculate the crude odds ratios for the age, sex, number of decayed teeth, missing teeth, filled teeth, remaining teeth, DMF, OHI-S, and CPI for correlation with the electrocardiogram abnormalities. Since there was a strong correlation with age and sex, the logistic regression analyses were carried out a second time and the odds ratios adjusted for age and sex were used to examine each of the factors for correlation with the electrocardiogram abnormalities. Wald test was used to determine significance and *P*-values less than 0.05 were considered to be statistically significant.

Results

Table 1 shows the prevalence and types of electrocardiogram abnormalities that were detected in this study. Table 2 shows the crude odds ratios and the odds ratios adjusted for age and sex used to examine the correlation of oral conditions with electrocardiogram abnormalities. The crude odds ratios determined by the logistic regression analyses for age, sex, number of missing teeth, number of filled teeth, OHI-S and CPI showed a statistically significant correlation with the prevalence of electrocardiogram abnormalities. However, there is a strong correlation with demographic factors such as sex and age for electrocardiogram abnormalities. Therefore, the factors representing the oral status were reexamined after the odds ratios were adjusted for age and sex. As a result of this adjustment, the odds ratios for the oral factors exhibited no correlation with the prevalence of electrocardiogram abnormalities. Table 3 shows the dose-response relationship between the oral conditions and the electrocardiogram abnormalities. There was no statistically significant correlation observed after adjustment of the odds ratios for age and sex. To examine the results of the blood analyses with regard to electrocardiogram abnormalities, the crude and adjusted odds ratios were calculated in the same way as described above. Table 4 shows the crude and the age and sex adjusted

Table 1 Electrocardiogram abnormality types and prevalence

	Type	n
0	Normal	479
1	High electric potential (lead that corresponds to the left ventricle or derivation that corresponds to the left ventricle)	14
2	Low electric potential (limb lead)	1
3	Hyperacute T wave	1
4	Low T wave	7
5	Coronary T wave	3
6	Slight ST-T elevation	0
7	ST-T abnormality	2
8	Sinus bradycardia	9
9	Sinus arrhythmia	3
10	PSR pattern	4
11	Complete right bundle branch block	0
12	Incomplete right bundle branch block	5
13	Left bundle branch forefoot block	6
14	Supraventricular extrasystole	7
15	Supraventricular extrasystole (frequent occurrence)	3
16	Ventricular premature beat (VPC)	2
17	Myocardial ischemia	1
18	Right axis deviation	1
19	Left axis deviation	0
20	Left ventricular hypertrophy	7
21	Left ventricular hypertrophy of doubt	6
22	Atrium sinistrum cordis load or the load of the left atrium of the heart	4
23	Atrium sinistrum cordis load rhythm of doubt	0
24	Load negative	0
25	Atrial fibrillation	1
26	High tachycardia	1
27	Coronary sinus rhythm	2
28	PR extension	4
29	PR shortening	1
30	PAC short run	1
31	Left ventricular hypertrophy and atrium sinistrum cordis (left atrium of the heart) hypertrophy	0
32	Slight ST-T abnormality of doubt	1
33	Ventricular premature beat (frequent occurrence)	1
34	Perfect left bundle branch block	1

Table 2 Crude odds ratios and odds ratios adjusted for age and sex used to examine the correlation of oral conditions with electrocardiogram abnormalities

	Crude odds ratio	95% CI	*P*-value	Adjusted odds ratio	95% CI	*P*-value
Age group	2.86	1.75 - 4.76	< 0.001			
Sex	1.06	1.03 - 1.08	< 0.001			
Number of decayed teeth	1.01	0.92 - 1.01	0.831	0.972	0.88 - 1.08	0.592
Number of missing teeth	1.04	1.00 - 1.08	0.035	0.99	0.95 - 1.04	0.675
Number of filled teeth	0.95	0.91-1.00	0.029	0.986	0.93 - 1.03	0.552
DMF	1.01	0.98 - 1.00	0.715	0.992	096 - 1.03	0.660
Number of remaining teeth	0.96	0.92 - 1.00	0.036	1.008	0.97 - 1.05	0.722
OHI-S	1.18	1.01 - 1.37	0.035	1.025	0.87 - 1.20	0.761
CPI	1.34	1.01 - 1.78	0.043	1.161	0.87 - 1.55	0.309

Crude odds ratios of age, sex, number of missing teeth, number of filled teeth, OHI-S and CPI showed a statistically significant correlation with the prevalence of electrocardiogram abnormalities. However, after adjustment for age and sex, none of the oral factors exhibited any correlation with the prevalence of coronary heart disease.

Table 3 Dose-response relationship between oral conditions and electrocardiogram abnormalities

	Adjusted odds ratio	95% CI	P-value
OHI-S			
0 -0.8			0.650
0.9-1.2	0.741	0.37-1.48	0.396
1.3-2.0	0.894	0.40-2.00	0.786
2.1-	1.151	0.59-2.24	0.680
Number of decayed teeth			
0			0.718
1	0.94	0,53-1.65	0.830
2-	0.737	0.35-1.54	0.419
Number of missing teeth			
0			0.423
1-3	1.528	0,79-2.97	0.212
4-	1.081	0.57-2.10	0.813
Number of filled teeth			
0-5			0.164
6-10	1.679	0.74-3.80	0.214
11-14	1.011	0.44-2.33	0.979
15-	1.953	0.88-4.32	0.098
DMF			
0-10			0.333
11-15	1.405	0.67-2.93	0.364
16-20	1.292	0.62-2.68	0.492
21-28	0.722	0.33-1.59	0.416
Number of remaining teeth			
0-24			0.705
25-27	0.941	0.48-1.84	0.857
28-	0.773	0.41-1.47	0.430
CPI			
0			
1	0.102	0.01-1.10	0.213
2	0.449	0.11-1.82	0.060
3	0.719	0.19-2.74	0.262
4	0.550	0.13-2.31	0.629

There was no statistically significant correlation for the odds ratios after adjustment for age and sex for any of the oral condition factors and the electrocardiogram abnormalities.

Table 4 Crude odds ratios and odds ratios adjusted for sex and age for correlation of blood analyses with electrocardiogram abnormalities

	Crude odds ratio	95% CI	*P*-value	Adjusted odds ratio	95% CI	*P*-value
Triglycerides levels (mg/dl)	1.00	1.00 - 1.01	0.03	1.001	1.00 - 1.01	0.658
HDL-cholesterol levels (mg/dl)	0.98	0.96 - 0.99	0.002	0.987	0.97 - 1.00	0.102
Creatinine levels (mg/dl)	32.10	7.73 - 13.3	< 0.0001	6.192	0.83 - 4.63	0.076
Blood sugar levels (mg/dl)	1.01	1.00 - 1.02	0.016	1.007	1.00 - 1.02	0.222
Fructosamine levels (µmol/l)	1.01	1.00 - 1.02	0.011	1.006	1.00 - 1.01	0.134
CRP (mg/dl)	0.95	0.38 - 1.75	0.917	0.867	0.34 - 2.23	0.767
Arteriosclerosis index	1.43	1.16 - 1.75	0.001	1.208	0.97 - 1.51	0.096
LDL-cholesterol levels (mg/dl)	1.01	1.00 - 1.01	0.143	1.004	1.00 - 1.01	0.326
Body mass index	0.95	0.92 - 0.99	0.023	1.005	0,95 - 1.07	0.864
Obesity index	1.15	0.97 - 1.37	0.114	1.116	.094 - 1.33	0.224

The crude odds ratios demonstrated six factors that had a statistically significant correlation with electrocardiogram abnormalities. However after adjusting the odds ratios for age and sex, no factors were found to have any statistically significant correlations.

odds ratios for the blood analyses. Six factors were demonstrated to have a statistically significant correlation with the electrocardiogram abnormalities. However, there were no factors that had a statistically significant correlation after the odds ratios were adjusted for age and sex.

Discussion

Recently, periodontal disease has been suggested to be a risk factor for systemic diseases such as diabetes, obesity, and circulatory diseases. Among these, there has been a special focus on coronary heart disease and cerebral vascular diseases. Several recent studies have shown a link between dental disease and coronary heart disease (2-5). In Finland, Mattila et al. in 1989 reported that poor dental health could be associated with acute myocardial infarction (2). In a prospective, cohort-designed study involving data from 9,760 American men who were examined three times between 1971 and 1987, de Stefano et al. found that there was a significant relationship between either periodontitis or edentulism and coronary heart disease (3). In a longitudinal aging study of U.S. veterans, Beck et al. found a significant association between periodontal disease, as measured by the extent of alveolar bone loss, and coronary heart disease and stroke (5). Loesche et al. studied 320 U.S. veterans in a convenience sample to assess the relationship between oral health and systemic diseases among older people. Coronary heart disease was 2.64 times more likely to be found in subjects with 1 to 14 teeth than in subjects with either 0 or 15 to 28 teeth (13).

These associations indicate that there may be some type of link between dental disease and cardiovascular disease. Because periodontal disease is a chronic infectious disease, etiological bacteria of the periodontal disease could be the source of the increased levels of the C-reactive protein (CRP), which has been suggested to be a predictor of myocardial infarction and stroke (24-26). Additionally, periodontal disease, which is the result of a complex interplay of bacterial infection and chronic inflammation, has also been suggested to be a predictor of cardiovascular disease. The associated bacteria cause arteriosclerosis of the heart and cardiovascular system and may lead to coronary artery disease (11,12).

However, the epidemiological studies that are described above are not sufficient to definitively prove that there is an association. This is due in part to insufficient sample sizes and the fact that these studies were not adjusted to account for other risk factors. Howell et al. examined a total of 8032 dentate adults aged 25 to 74 years with no reported history of cardiovascular disease. This group included 1859 individuals with periodontitis, 2421 with gingivitis, and 3752 with healthy periodontal tissues. This study did not find any convincing evidence of a causal association between periodontal disease and coronary heart disease risk (14). Moreover, Howell et al. sought to prospectively assess whether self-reported periodontal disease is associated with a subsequent risk of cardiovascular disease in a large population of male physicians (22,071 subjects). The prospective data suggested that self-reported periodontal disease was not an independent predictor of subsequent cardiovascular disease in middle-aged to elderly men (17).

As shown in Table 1, the electrocardiogram abnormalities observed were quite varied and we found that there was no statistically significant correlation between any of these abnormalities and periodontal disease (Tables 2,3). Additionally, there was also no correlation between the DMF factor and any of the electrocardiogram abnormalities (Tables 2,3). As far as we know, there have been no studies reported on the relationship between dental caries and coronary heart disease nor any *in vitro* studies on the relationship between *S. mutans* or lactobacillus and coronary heart disease.

OHI-S data have been used widely in a number of surveys and clinical trials. The criteria for this index are related to an oral debris score and a calculus score, and a correlation between OHI-S and periodontal disease has been reported in a previous study (27). However in our study, we found no such correlation between OHI-S and electrocardiogram abnormalities (Tables 2,3). With regard to blood analyses, there are some factors, such as CRP, that have been found to exhibit abnormal values in coronary heart disease patients. However in our study, no correlation was found between the blood analyses results and the electrocardiogram abnormalities (Table 4). This could be due to the fact that the electrocardiogram abnormalities analyzed in this study included very wide-ranging types of abnormalities.

The American Academy of Periodontal Disease has proposed that periodontal disease is related not only to local problems observed in the oral cavity and but may also reflect the systemic conditions of the host (28,29). Systematic conditions have been classified into three groups to assist in the treatment planning for periodontal disease. Using *in vitro* studies, etiological bacteria of periodontal diseases such as *P. gingivalis* has been found to enter into the intramyocardial endothelial cells (11,12). However, most of the etiological bacteria that have been reported are anaerobic, and thus evaluation systems cannot be fully established. This may be one of the most important problems responsible for the conflicting results with regard to the association between periodontal disease and systemic diseases (30-32).

On the other hand, a report by Tanaka et al. has suggested there is a correlation between tooth loss and electrocardiogram abnormalities (33). Evidence in the literature suggests that people with missing teeth change their eating habits after the loss of their teeth. This may lead to subjects avoiding certain nutritious foods because of difficulties in chewing, and the resultant selection of high-calorie, high-fat foods whose consumption is recognized as a risk factor for cardiovascular disease. Although it has been suggested that the prevention of heart disease is connected to the prevention of periodontal disease that causes tooth loss, in this study we could not find any correlations between periodontal conditions and electrocardiogram test results.

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