

Original article

Association between obesity and periodontal disease in Japanese factory workers

Seiki Tanada¹⁾ Yoshihito Oida²⁾ Hana Kozai³⁾
Yukie Yoshida³⁾ Masahide Imaki³⁾

- 1) Department of Public Health, Faculty of Pharmaceutical Sciences,
Kinki University
- 2) Belle époque College of Beauty
- 3) Department of Clinical Nutrition, Faculty of Comprehensive Rehabilitation,
Osaka Prefecture University

Abstract

In Japan, however, experimental or epidemiological studies on the correlation between obesity and periodontal diseases are rare. To shed some light on the relationship between obesity and periodontal diseases from the epidemiological viewpoint, the present study was conducted on about 1,470 healthy Japanese factory workers.

The results obtained were as follows: Compared to those with normal body weight, the odds ratio of obese individual developing periodontal diseases was 1.55. Even after adjusting for age and one's smoking habits, the ratio was 1.49, showing a significant difference between obese individuals and those of normal body weight. When compared to the subjects with a normal body weight, the odds ratio for those with a low body weight was 0.68. Even after adjusting for age and smoking habits, the ratio was 0.79, with no significant difference between the two groups.

It is presumed that the physiologically active substances secreted by the fat cells of obese persons exert effects on periodontal diseases by promoting their development.

(Jpn J Clin Ecol 15 : 28~34, 2006)

«Key words» obesity, periodontal disease, TNF- α , salivary occult bleeding, smoking

I . Introduction

Periodontal disease is the most prevalent chronic condition affecting about 70% of the population in this country. It was found recently that this affliction not only causes tooth loss: it is also responsible for systemic illnesses and is regarded as an important disease to be targeted for prevention, according to "Healthy

Japan 21"^{1~3)}.

For the primary prevention of periodontal diseases, many studies were conducted on the risk factors involved. Aging, diabetes mellitus, the presence of the subgingival bacteria, and smoking habits have been cited as potential risk factors^{4, 5)}. In addition, we noted that obesity is a new risk factor to be added to the

list⁶⁾. The reason is: obesity, which can be defined as a condition in which adipose tissue has accumulated excessively in the body, is considered to be a risk factor for life-style-related diseases^{7~9)}, such as diabetes mellitus, cerebral apoplexy, and heart diseases. With recent advances in fat cell biology, adipose tissue is now recognized not only as tissue where excess energy is stored but it also acts as an organ to produce and secrete various physiologically active substances¹⁰⁾. Among these, TNF- α , a cytokine secreted by fat cells, promotes bone resorption¹¹⁾ and is therefore suspected to be significantly related to the development of periodontal diseases that are characterized by resorption of the alveolar bone¹²⁾. In Japan, however, experimental or epidemiological studies on the correlation between obesity and periodontal diseases are rare. To shed some light on the relationship between obesity and periodontal diseases from the epidemiological viewpoint, the present study was conducted on about 2,000 healthy Japanese factory workers.

II. Methods

1. Subjects

The 1,963 (Men: 1,833 Women: 130) employees worked in a petroleum chemical plant where the major products were resins; vinyl chloride and polypropylene and chemical products like ammonia and urea. The employees included those who worked at the plant sites on 3-shifts; but most operated computer-controlled machinery so they were not likely to be exposed to toxic substances. The requirements for participation to this project were: 1) Men between the ages of 20 to 59 years (because there was little number of subjects, the women were excluded.); 2) Those who did not require more detailed examinations other than a routine health examination; 3) Those who were not given a

diagnosis of chronic diseases at the routine examination (such as cardiac disease or diabetes mellitus); 4) Those who did not report an abnormality, such as fatigue or a common cold on the day of the routine health examination.; 5) Those whose oral condition was measured in this study. The number of subjects ultimately selected were 1,470.

2. Recruitment phase survey methods

The subjects were requested to attend a morning clinic, where a standard medical examination was conducted and each individual's height, weight and blood pressure were recorded. Oral condition was measured by a standard core protocol and salivary occult bleeding test were conducted at a single laboratory. All the subjects were asked to respond to a self-administered questionnaire concerning their smoking habits.

Categories of tobacco use were defined as follows: smoking (subjects who smoked at the time of the interview); non-smoking (those with no smoking history); and quit smoking (those who had smoked habitually but stopped at least one month ago).

For the protection of the participant's privacy, disclosure of the research data was restricted; and for the statistical analyses a code was assigned to each subject so that he could not be identified when the results were published.

3. Examination of obesity and periodontal disease

Obesity index was evaluated by Body Mass Index (BMI). BMI was computed from one's body height and weight [BMI=body weight (kg)/body height (m)²]. The subjects were divided into 3 groups according to standard of WHO or Japan Society for the Study of Obesity (JASSO) – BMI<18.5 (Low body weight), 18.5 ≤BMI<25.0 (Normal body weight), and BMI

≥ 25.0 (Obese)¹³⁾.

With the aid of a salivary occult bleeding test, periodontal disease was diagnosed by measuring the amount of occult blood contained in the saliva. The test subjects were instructed to refrain from eating, drinking, or cleansing their oral cavity starting 2 hours prior to the scheduled oral examination; and were instructed to collect an appropriate amount of saliva just before the oral examination. After collecting a salivary specimen, "Salivaster-Bld." (Showa yakuhin kako. LTD.) was used immediately for semi-quantitative determination of the occult blood in the saliva. A diagnosis of this disease was based on a hemoglobin concentration of > 2.5 mg/dl in the saliva. A single examiner was responsible for collecting the salivary samples and in charge of evaluating all of the test results¹⁴⁾.

4. Statistical analysis

Association between prevalence of periodontal diseases and BMI was computed by using

logistic regression analysis¹⁵⁾. For the software for statistical analyses, Macintosh Statview Ver. 5.0 were used (SAS Institute Inc., Berkeley, USA). The significance level was set at $p < 0.05$.

III. Results

1. Characteristics of Subjects

Table 1 shows the age, smoking habits, BMI, and the amount of occult blood detected of the test subjects. The most of subjects ranged in ages from 40 to 49 years (34.9%); and current smokers were 55.7%. If the former and current smokers are combined, the total increased to 66.2%. BMI data indicated that 70.3% of them were of normal body weight and 26.4% were obese. The proportion of those suffering from periodontal diseases (detected by the salivary occult bleeding test) was 12.8%.

2. Relationship between BMI and prevalence of periodontal disease

Table 2 shows the results of a logistic regres-

Table 1 Characteristics of subjects

	N	Weighted %	Prevalence of Periodontal Disease %
Age (years)			
20 29	381	25.9	9.2
30 39	295	20.1	11.9
40 49	513	34.9	12.3
50 59	281	19.1	19.6
Total	1470	100	12.8
Smoking habits			
Non-smoking	492	33.8	14.2
Quit smoking	153	10.5	16.3
Smoking	812	55.7	11.0
Total	1457	100	12.6
Body mass index (kg/m ²)			
Underweight < 18.5	49	3.3	8.2
Normal 18.5 24.9	1033	70.3	11.5
Overweight 25	388	26.4	16.8
Total	1470	100	12.8
Salivary occult blood			
Hemoglobin < 2.5 (mg/dl)	1282	87.2	
Hemoglobin 2.5 (mg/dl)	188	12.8	
Total	1470	100	

sion analysis on the relationship between BMI and the prevalence of periodontal diseases. Compared to those with normal body weight, the odds ratio of obese individual developing periodontal diseases was 1.55. Even after adjusting for age and one's smoking habits, the ratio was 1.49, showing a significant difference between obese individuals and those of normal body weight. When compared to the subjects with a normal body weight, the odds ratio for those with a low body weight was 0.68. Even after adjusting for age and smoking habits, the ratio was 0.79, with no significant difference

between the two groups.

3. Relationship between BMI and prevalence of periodontal disease by age

Table 3 shows the results of a logistic regression analysis on the relationship between BMI (stratified by age) and periodontal diseases. In each age group between 20 and 59 years, the number of those contracting periodontal diseases was in ascending order: lowest for those with low body weight, followed by those with normal body weight, then obese individuals. The odds ratio for contracting periodontal diseases was also in ascending order, with lowest

Table 2 Crude and adjusted odds ratios and 95% confidence interval of body mass index (BMI) and periodontal disease by salivary occult bleeding test

		Crude OR (95%CI)	p value	Adjusted OR (95%CI)	p value
Body mass index (kg/m ²)					
Underweight	< 18.5	0.68 (0.241 - 1.932)	0.472	0.79 (0.276 - 2.234)	0.650
Normal	18.5 - 24.9	Reference		Reference	
Overweight	25	1.55 (1.114 - 2.145)	0.009	1.49 (1.070 - 2.086)	0.018

Odds ratios adjusted for smoking and age

Table 3 Crude and adjusted odds ratios and 95% confidence interval of body mass index (BMI) and prevalence of periodontal disease by age

Body mass index (kg/m ²)	N	Prevalence of periodontal Disease %	Crude OR (95%CI)	Adjusted OR (95%CI)
20 - 29 years				
Underweight	< 18.5	18	5.6	0.59 (0.075 - 4.608)
Normal	18.5 - 24.9	275	9.1	Reference
Overweight	25	88	10.2	1.14 (0.510 - 2.543)
30 - 39 years				
Underweight	< 18.5	9	11.1	1.00 (0.119 - 8.304)
Normal	18.5 - 24.9	215	11.2	Reference
Overweight	25	71	14.1	1.31 (0.591 - 2.881)
40 - 49 years				
Underweight	< 18.5	19	10.5	0.99 (0.219 - 4.437)
Normal	18.5 - 24.9	347	10.7	Reference
Overweight	25	147	16.3	1.64 (0.939 - 2.847)
50 - 59 years				
Underweight	< 18.5	3	0.0	
Normal	18.5 - 24.9	196	16.8	Reference
Overweight	25	82	26.8	1.81 (0.979 - 3.351)

Odds ratios adjusted for smoking

being those with the low body weight, followed by subjects with normal weight, then by obese subjects. A similar tendency was noted even after adjusting for smoking habits. However, there were no statistically significant differences among the groups.

IV. Discussion

Obesity, diabetes mellitus, hyperlipidemia, and hypertension, together called a "deadly quartet," constitute grave risk factors for life-style-related diseases. Among them, obesity forms the basis for the onset of diseases with a high mortality; therefore, epidemiological and experimental studies are still being continued to investigate the implication of obesity from diverse angles, such as mortality-morbidity of its sequelae and life style factors.

While studies on obesity are being advanced, its effect on the development of periodontal diseases is readily conceivable if one looks into the developmental mechanism of the latter. However, there are only a handful of studies that have been conducted on the relationship between periodontal diseases and obesity. Perlstein, et al. reported that periodontal diseases readily exacerbate in obese rats that also suffer from hypertension¹⁶⁾. In an epidemiological study on human subjects, Saito, et al. observed 241 healthy Japanese between the ages of 20 and 59 years to examine the correlation between BMI and CPI, an index for periodontal diseases. They reported that, compared with those with a BMI < 20.0, the relative risk of having a periodontal disease increased to 3.4 times in individuals with a BMI in a range of 25.0 to 29.9 and 8.6 times in those with a BMI > 30.0¹⁷⁾.

These researchers continued their study on 643 subjects living in the same area. This time, the waist-hip ratio was added to the test

parameters¹⁸⁾. It was found that the incidence of periodontal diseases increases in proportion to either BMI or the waist-hip ratio. Based on these observations, they concluded that among those with various types of obesity, periodontal diseases are particularly related to obesity of the upper half of the body; and the accumulation of fat in the visceral organs is likely to constitute a risk factor for periodontal diseases. Based on the results from the NHANES III study in the United States, Wood, et al. stated that obesity and attachment loss are significantly related¹⁹⁾. Al-Zahrani, et al. examined young adults between the ages of 18 and 34 and stated that compared with those of normal weight with a BMI ranging from 18.5 to 24.9, the relative risk of having a periodontal disease was 1.76 times greater in obese individuals with a BMI > 30.0⁶⁾.

These results suggest that the probability of developing periodontal diseases is significantly greater in obese individuals in comparison with their normal-body-weight counterparts. The current study differs slightly from Saito's in the categorization of BMI^{17, 18)}: with regard to obesity, a simple comparison of the results of epidemiological studies is not possible when the physical characteristics of Americans are obviously different from Japanese. However, like these earlier reports, the results of the current study indicated that the probability that an obese individual will develop a periodontal disease is significantly greater than those with normal body weight, the odds ratio being 1.55 times. Even after adjusting for age and smoking habits that are significantly related to periodontal diseases, the odds ratio was still 1.49 times greater. When the individuals were stratified into smaller groups according to their age, the probability of developing a periodontal disease increased in ascending order: in

each group, those with low body weight, normal weight, and obese individuals.

For the mechanism by which obesity becomes involved in the development of periodontal diseases, TNF- α , a cytokine secreted by fat cells, is suspected to be an important factor. While it is manufactured by monocytic cells among leukocytes and counteracts the adverse state caused by an external force, TNF- α also has an important role in acting against the stresses brought about by conditions such as inflammation and tissue destruction. Because of its action to promote bone resorption, it is understood that TNF- α is involved in the development of periodontal diseases that are characterized by resorption of the alveolar bone. In particular, a large quantity of TNF- α is secreted by the adipose tissue of obese individuals; and it is suspected to have a significant effect on resorption of the alveolar bone around one's teeth. Therefore, in addition to the action of that locally produced by macrophages, the TNF- α secreted by the adipose tissue also participates in the resorption of the alveolar bone, thus further aggravating the periodontal disease²⁰.

In addition to TNF- α , the physiologically active substances secreted by fat cells include PAI-1²¹, which may affect the development of periodontal diseases. An increase in the PAI-1 content in blood fosters an environment where thrombosis readily occurs in the microvasculature, augmenting the severity of periodontal diseases. Thus it is presumed that the physiologically active substances secreted by the fat cells of obese persons exert effects on periodontal diseases by promoting their development and exacerbation.

In addition to the effects described above, it is necessary to consider the combined effects of diabetes mellitus¹⁰. It is evident that diabetes

mellitus exacerbates periodontal diseases; but it is also necessary to consider the possibility that the some metabolic derangement caused by obesity that precedes the diabetic onset triggers or exacerbates periodontal diseases. It seems that obesity and the oral hygiene situation are associated. Furthermore, frequency of toothpaste and a snack are investigated, and it is necessary to analyze relation of obesity and periodontal disease.

Thus it is necessary to take approaches from both the experimental and epidemiological aspects to study the relationship between obesity and periodontal diseases.

Reference

- 1) Fowler EB, Breault LG, et al: Periodontal disease and its association with systemic disease. *Mil Med* 166: 85-89, 2001
- 2) Beck J, Garcia R, et al: Periodontal disease and cardiovascular disease. *J Periodontol* 67 (10 Suppl): 1123-1137, 1996
- 3) Wu T, Trevisan M, et al: Examination of the relation between periodontal health status and cardiovascular risk factors: serum total and high density lipoprotein cholesterol, C-reactive protein, and plasma fibrinogen. *Am. J Epidemiol* 151: 273-282, 2000
- 4) Genco RJ: Current view of risk factors for periodontal diseases. *J Periodontol* 67: 1041-1049, 1996
- 5) Bergstrom J, Eliasson S, et al: A 10-year prospective study of tobacco smoking and periodontal health. *J Periodontol* 71: 1338-1347, 2000
- 6) Al-Zahrani MS, Bissada NF, et al: Obesity and periodontal disease in young, middle-aged, and older adults. *J Periodontol* 74: 610-615, 2003
- 7) Doll S, Paccaud F, et al: Body mass index,

- abdominal adiposity and blood pressure: consistency of their association across developing and developed countries. *Int J Obes Relat Metab Disord* 26: 48-57, 2002
- 8) Burton BT, Foster WR, et al: Health implications of obesity: an NIH Consensus Development Conference. *Int J Obes* 9: 155-170, 1985
- 9) Field AE, Coakley EH, et al: Impact of over-weight on the risk of developing common chronic disease during a 10-year period. *Arch Intern Med* 161: 1581-1586, 2001
- 10) Iwamoto Y, Nishimura H: Obese • diabetes mellitus and periodontal disease. *Shikai Tenbou* 99: 181-188, 2002
- 11) Yang SQ, Lin HZ, et al: Obesity increases sensitivity to endotoxin liver injury: implications for the pathogenesis of steatohepatitis. *Proc Natl Acad Sci USA* 94: 2557-2562, 1997
- 12) Page RC, Kornman KS: The pathogenesis of human periodontitis: an introduction. *J Periodontol* 1997; 14: 9-11, 2000
- 13) World Health Organization: Obesity: preventing and managing the global epidemic. Report of a WHO consultation of obesity. World Health Organization, Geneva, Switzerland, 1997
- 14) Nakagawa K: A study on screening tests for periodontal disease – validity of the salivary occult bleeding test strips –. *J Dent Health* 38: 70-83, 1988
- 15) Tango T, Yamaoka K, et al: Logistic regression analysis. Asakura shoten, Tokyo, 1996 (in Japanese)
- 16) Perlstein MI, Bissada NF: Influence of obesity and hypertension on the severity of periodontitis in rats. *Oral Surg Oral Med Oral Pathol* 43: 707-719, 1977
- 17) Saito T, Shimazaki Y, et al: Obesity and periodontitis. *N Eng J Med* 339: 482-483, 1998
- 18) Saito T, Shimazaki Y, et al: Relationship between upper body obesity and periodontitis. *J Dent Res* 80: 1631-1636, 2001
- 19) Wood N, Johnson RB, et al: Comparison of body composition and periodontal disease using nutritional assessment techniques: Third National Health and Nutrition Examination Survey (NHANES III). *J Clin Periodontol* 30: 321-327, 2003
- 20) Friedman AN: Adiposity in dialysis: good or bad?. *Semin Dial* 19(2): 136-140, 2006
- 21) Shimomura I, Funahashi T, et al.: Enhanced expression of PAI-1 in visceral fat: possible contributor to vascular disease in obesity. *Nat Med* 2: 800-803, 2003

要約

脂肪細胞から分泌されるサイトカインの一種である TNF- α は、骨吸収を促進する作用があるため、歯槽骨の吸収を特徴とする歯周病の発症に大きく関連しているものと考えられる。しかし、我が国では、肥満と歯周病の関連性について検討した実験研究および疫学研究は殆ど見あたらない。本研究では、肥満と歯周病の関連性を疫学的に明らかにするため、健康な日本人大規模事業所従業員約1,470名を対象に検討した。肥満者は普通体重者に比較して、歯周病に罹患するオッズ比は1.55であった。年齢、喫煙習慣の調整後も1.49であり、統計的に有意な差異を認めた。低体重者は普通体重者に比較して、オッズ比は0.68であった。年齢、喫煙習慣の調整後も0.79であったが、統計的に有意な差異はなかった。

このように肥満者における脂肪細胞の生理活性物質が歯周病に影響を与え、発症を促進していると推定される。

(臨床環境15 : 28~34, 2006)