Title	Factors associated with root surface caries in elderly
Author(s)	Sugihara, N; Maki, Y; Okawa, Y; Hosaka, M; Matsukubo, T; Takaesu, Y
Journal	Bulletin of Tokyo Dental College, 51(1): 23-30
URL	http://hdl.handle.net/10130/1558
Right	

Original Article

Factors Associated with Root Surface Caries in Elderly

Naoki Sugihara, Yoshinobu Maki, Yoshikazu Okawa*, Makoto Hosaka*, Takashi Matsukubo and Yoshinori Takaesu

Department of Epidemiology and Public Health, Tokyo Dental College,
1-2-2 Masago, Mihama-ku, Chiba 261-8502, Japan
* Department of Oral Hygiene, Chiba Prefectural University of Health Sciences,
2-10-1 Wakaba, Mihama-ku, Chiba 261-0014, Japan

Abstract

The purpose of this study was to determine the risk factors for root surface caries in the elderly and to evaluate the factors associated with gingival recession, one of the main risk factors for root surface caries. A total of 153 elderly people (35 men, 118 women) aged between 60 and 94 years (73.5 ± 7.5 years) were surveyed. All participants were relatively healthy elderly who did not need special care in their daily lives. The survey was conducted in Chiba prefecture, Japan, and oral examinations and a questionnaire with face-to-face interviews were also carried out. Correlation analysis revealed that number of present teeth ($p < 0.001$), gingival recession ($p < 0.001$), bleeding on probing ($p < 0.001$) and presence or absence of dentures ($p < 0.05$) were significantly correlated with number of root surface caries. Stepwise multiple linear regression analysis for root surface caries revealed that the risk factors for increasing numbers of teeth with root surface caries were number of teeth with gingival recession ($p < 0.0001$), bleeding on probing ($p = 0.0017$) and self-reported dry mouth ($p = 0.0454$). Sex ($p < 0.05$), number of present teeth ($p < 0.001$), bleeding on probing ($p < 0.01$), the presence or absence of systemic disease ($p < 0.01$), dentures ($p < 0.01$), drinking alcohol ($p < 0.01$) and smoking ($p < 0.01$) were significantly correlated with amount of gingival recession by correlation analysis. Moreover, the risk factors for increasing number of teeth with gingival recession were living in an institution ($p = 0.0244$), number of present teeth ($p < 0.0001$) and smoking ($p = 0.0037$), as determined by stepwise multiple linear regression analysis for gingival recession.

Key words: Root surface caries—Gingival recession—Elderly—Risk factors—
            Cross-sectional survey

Introduction

Root surface caries is a significant oral health problem in the elderly, and the incidence of root surface caries has been found to be one of the main risk factors for tooth loss in older adults[3,7]. Hand *et al.* investigated the 5-year incidence of tooth loss in 340 community-dwelling Iowans aged 65 and older and found that the risk factors for tooth loss were decayed root surfaces, decayed coronal surfaces, teeth with deep pockets and sex[3].

The Japanese government launched the "Healthy Japan 21" campaign in 2000 with 2010 as the target year, and the Ministry of Health, Labor and Welfare set goals within nine areas. One of these areas was oral health, and one of the four goals they set for 2010 in Healthy Japan 21 was the prevention of tooth loss[10]. Therefore, it is important to prevent the occurrence of root surface caries in older adults to prevent tooth loss in Japan. However, we do not have any national-survey data regarding root surface caries.

We have reported the prevalence, diagnosis, treatment and prevention of root surface caries in Japan since 1991[8,11,12,16]. In 1993, we reported that the prevalence of root surface caries (active root caries and root fillings) in 770 company employees was 1.3% in those aged 20–29 years, 10.5% in those aged 30–39, 18.5% in those aged 40–49 and 36.3% in those aged 50–59[11]. We also reported in 1994 that the prevalence of root surface caries (active root caries and root fillings) in 161 healthy elderly was 24.5% in those aged 60–69 years, 21.6% in those aged 70–79 and 20.6% in those aged 80 and over[12]. We found that the percentage of subjects with root surface caries increased with age in adults but did not increase with age in the elderly due to the decreasing number of present teeth.

Saunders and Meyerowitz[13] reported that the occurrence of root surface caries in the elderly differs from that in younger people in that older people have many additional risk factors that increase their susceptibility to it. Furthermore, we analyzed the risk factors for root surface caries using previous data on the elderly[12,15]. The purpose of this study was to determine the risk factors for root surface caries in the elderly. Moreover, we evaluated the factors associated with gingival recession, which are significant risk factors for root surface caries.

Materials and Methods

1. Participant characteristics and methods

A total of 265 elderly aged 60–94 years were examined between 1990 and 1991[15]. The participants consisted of institutionalized and non-institutionalized elderly. All participants were relatively healthy and dentate and did not need special care in their daily lives. The survey was conducted in Chiba prefecture, Japan. The oral examinations were based on WHO criteria[19]. A questionnaire with face-to-face interviews was carried out by three dentists. We only analyzed 153 of the 161 responses to the questionnaires.

2. Diagnostic criteria in root surface caries and gingival recession

The prevalence of root caries in this study was assessed by focusing on active-root and filled-root lesions. Active lesions (soft lesions) were defined as those that were located at the cement-enamel junction (CEJ) or on the root surface only. Lesions comprised well-defined, softened and discolored areas which the explorer entered easily but displayed some resistance on withdrawal from. Recurrent softened lesions were also recorded as active lesions. Restoration strictly confined to the root surface was recorded as a filled lesion. When the original caries area that had been treated was uncertain, more than half the filling material located on the root surface was recorded as root fillings. Gingival recession was considered present if any root surface was clearly visible.

3. Data analysis

For the correlation analysis, Pearson's correlation coefficients were calculated between the number of root surface caries or teeth with gingival recession and binary variables. Spearman's rank correlation coefficients were calculated between the number of surface caries or teeth with gingival recession and continuous variables. Stepwise multiple linear regression analysis was used to determine which risk factors were significantly associated with number of root surface caries and teeth with gingival recession, and these were described as partial regression coefficients with SE, standardized partial regression coefficients and provability. Statistical significance was set

at p<0.05. The statistics were analyzed with the SAS version 9.1 for Windows (SAS Institute, Cary, NC, USA).

Results

Table 1 lists the participants, their characteristics and oral conditions in this study. A total of 153 elderly people (35 men, 118 women) aged between 60 and 94 years (mean age: 73.5 ± 7.5 years) were surveyed. The participants consisted of 76 non-institutionalized and 77 institutionalized persons. Sixty participants (39.2%) had a spouse and 106 (69.3%) had systemic diseases such as cerebrovascular disease, diabetes, and hypertension. The mean number of present teeth, decayed root surfaces and filled root lesions corresponded to 12.9, 0.23 and 0.39. In periodontal status, the mean number of teeth with gingival recession, bleeding on probing and periodontal pockets

Table 1 Participants, characteristics and oral conditions

<Participants>		
		Frequency (%)
Sex		
	Men	35 (22.9)
	Women	118 (77.1)
Age (in years)		
	60–69	52 (34.0)
	70–79	69 (45.1)
	80–94	32 (20.9)
<Characteristics>		
		Frequency (%)
Living situation		
	Non-institutionalized	76 (49.7)
	Institutionalized	77 (50.3)
Spouse		
	No	93 (60.8)
	Yes	60 (39.2)
Systemic disease		
	No	47 (30.7)
	Yes	106 (69.3)

<Oral conditions>	Range	Mean (S.D.)
Present teeth	1–30	12.9 (8.7)
Coronal decayed teeth	0–22	1.9 (3.5)
Gingival recession	0–21	2.7 (4.1)
Root surface caries	0–17	0.61 (1.80)
Active lesions	0–4	0.23 (0.68)
Filled lesions	0–17	0.39 (1.67)
Bleeding on probing	0–15	2.24 (3.10)
Periodontal pockets ($\geq$4mm)	0–16	2.25 (2.95)

		Frequency (%)
Dentures wearer		
	No	45 (29.4)
	Yes	108 (70.6)
Self-reported dry mouth		
	No	105 (68.6)
	Yes	48 (31.4)

($\geq$4 mm) corresponded to 2.7, 2.24 and 2.25. One-hundred eight elderly (70.6%) were denture wearers and 48 (31.4%) had self-reported dry mouth.

Table 2 lists the health behaviors and habits of the participants. The mean number of times teeth were brushed was 2.0 and that for the intake of snacks was 1.0 per day. We investigated their dental visits regarding three dental-care utilization patterns: dental visits made in the past year, visits to the same dentist and regularity of visits. Eighty participants (52.3%) who made dental visits in the past year, 102 (66.7%) had visited the same dentist and 10 (6.5%) had had regular dental check-ups. In terms of habits, 31 (20.3%) drank alcohol regularly and 24 (15.7%) were smokers.

The results of the correlation analysis between number of root caries and risk factors are shown in Table 3. Number of present teeth, teeth with gingival recession, and teeth with

Table 2   Health behaviors and habits

	Range	Mean (S.D.)
Tooth-brushing frequency	0–6	2.0 (1.0)
Frequency of snacks	0–4	1.0 (1.0)
		Frequency (%)
Dental visits in past year		
No		73 (47.7)
Yes		80 (52.3)
Same dentist		
No		51 (33.3)
Yes		102 (66.7)
Regular dental check-ups		
No		143 (93.5)
Yes		10 (6.5)
Drinking alcohol		
No		122 (79.7)
Yes		31 (20.3)
Smoking		
No		129 (84.3)
Yes		24 (15.7)

Table 3   Correlation coefficients and significance between root surface caries and other factors

Factors	Root surface caries
Sex (0: Men, 1: Women)	−0.05088
Age	−0.06838
Living situation (0: Non-institutionalized, 1: Institutionalized)	0.05272
Spouse (0: No, 1: Yes)	0.03460
Systemic disease (0: No, 1: Yes)	−0.05846
Present teeth	0.29159***
Coronal decayed teeth	−0.04736
Gingival recession	0.51535***
Bleeding on probing	0.32255***
Periodontal pockets ($\geq$4 mm)	0.10753
Dentures wearer (0: No, 1: Yes)	−0.16528*
Self-reported dry mouth (0: No, 1: Yes)	0.05790
Tooth-brushing frequency	−0.01101
Frequency of snacks	−0.03009
Dental visits in past year (0: No, 1: Yes)	−0.04197
Same dentist (0: No, 1: Yes)	−0.04253
Regular dental check-ups (0: No, 1: Yes)	0.04200
Drinking alcohol (0: No, 1: Yes)	0.04254
Smoking (0: No, 1: Yes)	0.10298

*: $p < 0.05$, ***: $p < 0.001$
Pearson's correlation coefficients were calculated between root surface caries and binary variables.
Spearman's rank correlation coefficients were calculated between root surface caries and continuous variables.

bleeding on probing obtained with Pearson's correlation coefficient, and the presence or absence of dentures obtained with Spearman's rank correlation coefficient were significantly correlated with the number of root surface caries. We performed stepwise multiple linear regression analysis to determine which factors were associated with root surface caries after forcing sex and age in the model (Table 4). The dependent variable was number of root surface caries and the independent variables were the 19 factors listed in Table 3. Based on *a priori* entry and exit criteria, stepwise-model building resulted in a final linear regression

Table 4 Stepwise multiple linear regression analysis for root surface caries

Independent variables	β_1*	SE	β_2**	p
Sex	0.10622	0.28965	0.02493	0.7144
Age	0.00552	0.01639	0.02302	0.7370
Gingival recession	0.20719	0.03069	0.47346	p<0.0001
Bleeding on probing	0.12843	0.04008	0.22193	0.0017
Self-reported dry mouth	0.52575	0.26055	0.13628	0.0454

$R^2 = 0.3310$
*β_1: Partial regression coefficient
**β_2: Standardized partial regression coefficient
Dependent variable was number of root surface caries.
Independent variables were 19 factors shown in Table 3.
This model included compulsory sex and age to adjust for confounding factors.

Table 5 Correlation coefficients and significance between gingival recession and other factors

Factors	Gingival recession
Sex (0: Men, 1: Women)	−0.18611*
Age	−0.14308
Living situation (0: Non-institutionalized, 1: Institutionalized)	−0.02193
Spouse (0: No, 1: Yes)	0.05526
Systemic disease (0: No, 1: Yes)	−0.22434**
Present teeth	0.43499***
Coronal decayed teeth	−0.04588
Bleeding on probing	0.21918**
Periodontal pockets (≥4mm)	0.06010
Dentures wearer (0: No, 1: Yes)	−0.21848**
Self-reported dry mouth (0: No, 1: Yes)	−0.02278
Tooth-brushing frequency	0.04339
Frequency of snacks	−0.01685
Dental visits in past year (0: No, 1: Yes)	−0.00284
Same dentist (0: No, 1: Yes)	0.05137
Regular dental check-ups (0: No, 1: Yes)	0.04660
Drinking alcohol (0: No, 1: Yes)	0.20901**
Smoking (0: No, 1: Yes)	0.23447**

*: p<0.05, **: p<0.01, ***: p<0.001
Pearson's correlation coefficients were calculated between gingival recession and binary variables.
Spearman's rank correlation coefficients were calculated between gingival recession and continuous variables.

model that included five variables: sex, age, teeth with gingival recession, bleeding on probing and self-reported dry mouth. From this analysis, the risk factors for increasing the number of teeth with root surface caries were number of teeth with gingival recession (p<0.0001), number of teeth with bleeding on probing (p=0.0017) and having a self-reported dry mouth (p=0.0454).

The results of correlation analysis between the number of teeth with gingival recession and risk factors are listed in Table 5. Number of present teeth and teeth with bleeding on probing obtained with Pearson's correlation coefficient, and sex, systemic disease, dentures, drinking alcohol and smoking obtained with Spearman's rank correlation coefficient were significantly correlated with gingival recession. We performed stepwise linear multiple regression analysis to determine which factors were associated with gingival recession after forcing sex and age in the model (Table 6). The dependent variable was the number of teeth with gingival recession and the independent variables were the 18 factors listed in Table 5. Based on *a priori* entry and exit criteria, stepwise-model building resulted in a final linear regression model that included six variables: sex, age, living situation, number of present teeth, smoking and systemic disease. The risk factors from this analysis for increasing the number of teeth with gingival recession were living in an institution (p=

0.0244), number of present teeth (p<0.0001) and smoking (p=0.0037).

Discussion

Extensive epidemiological studies on risk factors for root surface caries have been carried out by numerous investigators throughout the world[1,13]. Japanese epidemiological studies on the elderly[4,5,17] have reported that having decayed roots, mean loss of attachment (≥3.6), prosthetic crowns (≥2), higher mutans streptococci and lactobacilli levels, poor oral-hygiene status, low salivary flow, perceived dry mouth, interdental brushing or dental flossing and a high body mass index (>20) were significant risk factors for root surface caries. Also, Yoshihara *et al.* reported that older people with hypoalbuminemia were at high risk for root caries and the intake of milk and milk products was negatively correlated with root caries events[20,21].

The definition of root surface caries is the occurrence of dental cavities in exposed roots and the main cause of root surface caries is gingival recession, including loss of attachment. In this study, number of teeth with gingival recession was also the most significant risk factor for root surface caries. In addition, periodontal status (bleeding on probing) and self-reported dry mouth were risk factors for root surface caries.

Table 6 Stepwise multiple linear regression analysis for gingival recession

Independent variables	β_1*	SE	β_2**	p
Sex	−0.19151	0.73109	−0.01967	0.7937
Age	−0.02377	0.04490	−0.04341	0.5973
Living situation	1.51494	0.66597	0.18517	0.0244
Present teeth	0.21894	0.03690	0.46204	p<0.0001
Smoking	2.43053	0.82501	0.21609	0.0037
Systemic disease	−1.08930	0.64849	−0.12285	0.0951

R^2=0.2676
*β_1: Partial regression coefficient
**β_2: Standardized partial regression coefficient
Dependent variable was amount of gingival recession.
Independent variables were 18 factors shown in Table 5.
This model included compulsory sex and age to adjust for confounding factors.

To prevent root surface caries, we should first prevent gingival recession and, if not possible, then prevent demineralization of exposed roots. Therefore, we evaluated not only the risk factors for root surface caries but also the risk factors for gingival recession in this study. Frequent tooth-brushing and poor oral health were significant risk factors in epidemiological studies on gingival recession in adults[6,18]. Smoking was also a significant risk factor for periodontal disease[2,9]. In this study, living in an institution, number of present teeth and smoking were significant risk factors for gingival recession. As non-institutionalized elderly had more present teeth and smoked more frequently than the institutionalized elderly[15], number of teeth with gingival recession may be significantly associated with living situation. Slade *et al.* reported that pre-existing sociodemographic factors prior to institutionalization were responsible for the higher probability of oral disease[14].

We were unable to clearly identify the causality between root surface caries or gingival recession and associated factors because this study was a cross-sectional survey. However, number of teeth with gingival recession, bleeding on probing and self-reported dry mouth were significantly associated with number of root surface caries. Furthermore, living situation, number of present teeth and regular smoking were significantly associated with number of teeth with gingival recession.

References

1) Beck J (1990) The epidemiology of root surface caries. J Dent Res 69:1216–1221.
2) Gunsolley JC, Quinn SM, Tew J, Gooss CM, Brooks CN, Schenkein HA (1998) The effect of smoking on individuals with minimal periodontal destruction. J Periodontol 69:165–170.
3) Hand JS, Hunt RJ, Kohout FJ (1991) Five-year incidence of tooth loss in Iowans aged 65 and older. Community Dent Oral Epidemiol 19: 48–51.
4) Ikebe K, Imazato S, Izutani N, Matsuda K, Ebisu S, Nokubi T, Walls AW (2008) Association of salivary *Streptococcus mutans* levels determined by rapid detection system using monoclonal antibodies with prevalence of root surface caries. Am J Dent 21:283–287.
5) Imazato S, Ikebe K, Nokubi T, Ebisu S, Walls AW (2006) Prevalence of root caries in a selected population of older adults in Japan. J Oral Rehabil 33:137–143.
6) Joshipura KJ, Kent RL, DePaola PF (1994) Gingival recession: intra-oral distribution and associated factors. J Periodontol 65:864–871.
7) Locker D, Ford J, Leak L (1996) Incidence of and risk factors for tooth loss in a population of older Canadians. J Dent Res 75:783–789.
8) Maki Y, Sugihara N, Ishihara H, Enoki H, Takaesu Y, Yuasa T (2000) Questionnaire survey on diagnosis, treatment and prevention of root surface caries. J J Gerodont 15:31–39. (in Japanese)
9) Martinez-Canut P, Lorca A, Magan R (1995) Smoking and periodontal disease severity. J Clin Periodontol 22:743–749.
10) Ministry of Health, Labor and Welfare (2009) Annual Health, Labor and Welfare Report 2007–2008. http://www.mhlw.go.jp/english/wp/wp-hw2/index.html, accessed on November 10, 2009.
11) Okawa Y, Sugihara N, Maki Y, Ikeda Y, Takaesu Y (1993) Prevalence of root caries in a Japanese adult population aged 20–59 years. Bull Tokyo Dent Coll 34:107–113.
12) Okawa Y, Sugihara N, Maki Y, Ishihara H, Takaesu Y (1994) Prevalence of root caries in an elderly population. J Dent Hlth 44:2–8. (in Japanese)
13) Saunders RH Jr, Meyerowitz C (2005) Dental caries in older adults. Dent Clin North Am 49: 293–308.
14) Slade GD, Locker D, Leake JL, Price SA, Chao I (1990) Differences in oral health status between institutionalized and non-institutionalized older adults. Community Dent Oral Epidemiol 18: 272–276.
15) Sugihara N (1992) Evaluation for variable factors in oral health of institutionalized and non-institutionalized elderly. Shikwa Gakuho 92:231–250. (in Japanese)
16) Sugihara N, Okawa Y, Maki Y, Takaesu Y, Musha Y (1991) Prevalence of root surface caries in an adult population. J Dent Hlth 41:105–107. (in Japanese)
17) Takano N, Ando Y, Yoshihara A, Miyazaki H (2003) Factors associated with root caries incidence in an elderly. Community Dent Health 20:217–222.
18) Vehkalahti M (1989) Occurrence of gingival recession in adults. J Periodontol 60:599–603.
19) World Health Organization (1987) Oral health surveys, basic methods, 3rd ed., pp. 37–41,

World Health Organization, Geneva.

20) Yoshihara A, Takano N, Hirotomi T, Ogawa H, Hanada N, Miyazaki H (2007) Longitudinal relationship between root caries and serum albumin. J Dent Res 86:1115–1119.

21) Yoshihara A, Watanabe R, Hanada N, Miyazaki H (2009) A longitudinal study of the relationship between diet intake and dental caries and periodontal disease in elderly Japanese subjects. Gerodontology 26:130–136.

Reprint requests to:
Dr. Naoki Sugihara
Department of Epidemiology and Public Health,
Tokyo Dental College,
1-2-2 Masago, Mihama-ku,
Chiba 261-8502, Japan
Tel: +81-43-270-3746
Fax: +81-43-270-3748
E-mail: sugihara@tdc.ac.jp