

Factors Related to Tooth Loss in Later Years during a Long-term Maintenance Program at Dental Clinics

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Abstract : The present study was conducted in order to identify risk-factors for tooth loss among patients in a long-term maintenance program at dental clinics, as well as factors specifically related to the elderly. Subjects were selected from patients who had been in a maintenance program more than 15 years and who made their last dental visit between July and October 2004. The patients attended one of two private dental clinics where one of the authors has been working in Osaka. Annual tooth loss for each subject was calculated from the difference of tooth loss between the first visit and the last visit.

The average length of maintenance, between the base line and the last visit, was 27.5 years for those younger than 39 years, and 25.8 years for those older than 40 years at the base line. The annual average tooth loss was 0.040 for the younger group and 0.115 for the older group, not including wisdom teeth. Multiple regression analysis showed that individuals aged 40 and older with more non-vital teeth and more teeth with periodontal pocket depth at the first visit, as well as retaining a smoking habit and suffering diabetes mellitus during the maintenance period had a higher rate of annual tooth loss, whereas individuals with fewer teeth and more teeth with periodontal pockets showed co-relation with higher rate of annual tooth loss for the younger age group.

The results suggested that not only periodontal disease but also pulpectomy, as well as smoking and diabetes mellitus, could be the risk-factors of tooth loss in the later years even if a long-term maintenance program could be provided after 40 years of age.

Key words : long-term maintenance, tooth loss, number of present teeth, number of non-vital teeth

Introduction

To achieve the target of 'Healthy Japan 21', adults are encouraged to have regular dental visits for professional cleaning, and to have regular dental health check-ups. This target of keeping 20 or more teeth at the age of 80 years old, expressed as "Eighty-Twenty (80/20)", was based on a concept of oral health as a crucial component of general health¹⁾. Keeping natural teeth has been shown to be an important factor for health in later years. Manly and Braley²⁾ tried to evaluate the effect of

tooth loss and showed that masticatory performance and efficiency decreased with loss of teeth. Agerberg and Carlsson³⁾ reported a definite relationship between chewing ability and general health status in randomly selected persons aged 15~74 years. Through a community based survey, Shinsho¹⁾ found that the percentage of elderly people who were active enough to go out alone correlated with number of natural teeth. Prolongation of tooth life also has been thought to enhance the quality of life⁴⁾.

Tooth loss is not a natural result of age, and there is abundant evidence of preventing tooth loss through professional care. Axelsson and Lindhe⁵⁾ also observed that "a preventive program which

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stimulates individuals to adopt proper oral hygiene habits may resolve gingivitis and prevent progression of periodontal disease and caries". Prevention of caries and periodontal disease are the critical factors in preventing tooth loss in adults^{6~8)}. Prevention of those diseases can be carried out by community education programs associated with regular check-ups and adequate plaque control programs^{9,10)}. Many studies also showed the effect of regular, professional prevention programs for reducing the incidence of tooth loss. Tooth loss was more likely to occur among individuals who received no maintenance or discontinued receiving maintenance¹¹⁾. Among professional care, regular dental visit is thought to be one of the most important procedures for keeping oral health. Sheiham *et al.*¹²⁾ observed that a regular dental attendance pattern was negatively associated with the number of missing teeth, and positively associated with the number of filled teeth. Shinsho *et al.*¹³⁾ and Shinsho¹⁴⁾ found that, in adults aged 40 and over, the mean number of teeth lost per year was lower for those who had been receiving prophylactic treatment and oral health instructions through regular dental visits than for those who had not done so.

Thus, providing maintenance care at dental clinics is well recognized as a procedure for preventing tooth loss and it is expected to assure better quality of life in the later years. However, even during the period of maintenance care, tooth loss can be observed, although there is little evidence of risk factors of tooth loss for the elderly under long-term maintenance care. Risk factors of tooth loss during maintenance care of elderly patients may be different from the factors for general physical health, and may be different also between younger generation and elder generation.

Furthermore, as diabetes mellitus and smoking are well known to have strong correlations with periodontal disease^{15~18)}, these diseases can be risk factors of tooth loss. The present study was

conducted in order to identify risk factors for tooth loss among the patients attending a long-term maintenance program at dental clinics, with a special emphasis on factors related to the elderly.

Subjects and Methods

Subjects of this research were those who had been using a continuing maintenance program provided at one of two dental clinics where one of the authors has been working in Osaka. In the clinics, continuing maintenance care focusing on prevention of diseases of the entire oral cavity has been provided over 35 years. In these clinics, after a series of initial treatment of oral diseases, regular dental visits for maintenance care have been recommended for most of the patients, to provide prophylactic treatment and guidance for preventive self care. Once every 1~6 months, patients with periodontal disease received oral hygiene prophylaxis including scaling and root planing if needed.

Subjects were selected from patients who had been receiving the maintenance care for more than 15 years and made the last dental visit during the 4 months between July and October in 2004 at either of two dental clinics. The number of those who were registered to use regular maintenance care at these clinics was 2,265 in July, 2004. In 1989, the number of those who registered for maintenance care was 1,786. Among these 984 were registered both in 1989 and 2004, and also continued regular dental visits at least once every six months for 15 years. Those who made irregular dental visit were excluded, as were those who dropped out within 15 years including those who died or moved away. The total number of subjects who met the above-mentioned conditions making dental visit between July and October in 2004 was 371 (130 men and 241 females). Thus the 371 subjects of this research, represent 38 percent of those registered both in 1989 and 2004, and also who continued regular dental visits at least once every six months between

Table 1 Number of people registered for maintenance care at the dental clinics of this study and the subject of this study

	n
Number of people registered for maintenance care in 1989	1,786
Number of people registered for maintenance care in 2004	2,265
Number of those registered both in 1989 and 2004, who continued regular dental visit at least once every six months between 1989~2004	984
Number of total subjects who made a dental visit between July and October 2004	371

Table 2 Number of subjects by length of maintenance care

		Age at the last visit (years)					Total
		35~49	50~59	60~69	70~79	80~	
Length of maintenance care (years)	15~20	7	10	12	11	1	41
	21~25	9	20	40	28	10	107
	26~30	6	19	36	28	13	102
	31~37	2	13	31	55	20	121
Total		24	62	119	122	44	371
Average years of maintenance		22.4	25.4	26.1	28.0	28.4	26.6

1989~2004 (Table 1).

The subjects' average age at the start of the maintenance care was 41.5 years (from 14 years to 67 years old). At the last visit their average age was 67.5 years (from 36 years to 93 years old) (Table 2).

The average length of maintenance care for the subjects was 25.2 years (ranging from 10.4 to 36.7 years) (Table 2).

At the base line before starting the maintenance program, the average number of teeth of the 371 subjects was 24.9. Those subjects with complete dentures were excluded. The annual tooth loss for each subject was calculated from the difference of the number of teeth between the base line and the final visit. At the final visit, all the patients were

asked to complete a questionnaire regarding general health, including their medical history of diabetes mellitus, circulatory disease and disease of the digestive organs, and also about smoking.

The condition of each tooth was classified into healthy, filling, crown, non-vital from endodontics, and missing. The annual tooth loss was compared based on the following items : 1. age, 2. age at the base line, 3. number of present teeth at the base line, 4. number of teeth treated at the base line, 5. presence of periodontal pocket depth over 4 mm at the base line. The periodontal pocket depth was measured using a periodontal probe at 6-point for each tooth.

According to the response to the questionnaire at the final visit, the annual tooth loss was also

Table 3 Mean number of present teeth by age and sex

		Age at last visit (years)					Total
		35~49	50~59	60~69	70~79	80~	
Male	present teeth	27.9	26.7	23.9	22.2	17.1	23.3
	n	9	21	40	47	13	130
Female	present teeth	28.1	26.3	24.0	22.1	19.3	23.5
	n	15	41	79	75	31	241
Total	present teeth	28.0	26.5	24.0	22.1	18.6	23.4

compared based on the following items: 6. the presence of systemic diseases, such as diabetes mellitus, circulatory disease and disease of the digestive organs, and 7. smoking.

It has been pointed out that "periodontal disease (23.4% overall) was the most frequent indication for extraction and became the commonest cause of tooth extraction in patients aged 40 years and more", while in 20~39 year olds, "dental caries (56.4% overall) was the main reason for tooth extraction"¹⁹⁾. And a national survey in Japan reported that over 80 percent of over 40 year olds had periodontitis²⁰⁾. So, in this study, subjects were divided into two groups by age of the baseline, under 40 year-olds over 40 year-olds. The significance of differences was analyzed by Student's t-test or analysis of variance (ANOVA). Stepwise multiple regression analysis was also performed, using as the independent variables, factors which showed a significant relationship with the annual tooth loss.

Results

The mean number of present teeth of the subjects at the last visit was 23.4 as a whole (Table 3).

It was 25.4 for the younger age group, and 21.6 for the older age group at the last visit (Table 4). Annual tooth loss on average was 0.086 for male and 0.075 for female, not including wisdom teeth. It was 0.040 for the younger age group, and 0.115 for the older age group (Table 4). Comparing situa-

tions at the base line among the two age groups, the number of present teeth and number of filled teeth were significantly larger in the younger group. The number of non-vital teeth and the proportion of those with periodontal pocket depth over 4 mm were larger in the older group. Comparing the situation at the last visit between the two age groups, these were significantly more subjects with circulatory disease and above average annual tooth loss in the older group, both male and female (Table 4).

Comparing the annual tooth loss during the maintenance period by general and oral health situation for both the age groups, it was significantly smaller in those subjects with more present teeth at the base line, for both age groups, and was significantly smaller in those subjects with more filled teeth at the base line, for the younger group. The annual tooth loss were also significantly bigger in those subjects with more non-vital teeth at the base line, and in those who had periodontal pocket depth over 4 mm, at the base line, for both age groups. The annual tooth loss was also significantly bigger among smokers and those with diabetes mellitus at the last visit for the older age group (Table 5).

Multiple regression analysis showed that the number of present teeth and presence of periodontal pocket depth over 4 mm at the base line were significantly related to the annual tooth loss during the maintenance period, for the younger group. It

Table 4 Comparison of oral health situation or the number of subjects by health status between two groups divided by age at the base line

			Age at the base line		Total	p-value
			Less than 40 years old mean = 32.6	40 years old and more mean = 49.7		
Situation at the base line	Male		62	68	130	
	Female		117	124	241	
	Number of present teeth (mean)		26.0	23.9	24.9	0.000
	Number of filled teeth (mean)		6.5	3.8	5.1	0.020
	Number of vital teeth with crown (mean)		2.6	3.7	3.2	0.108
	Number of non-vital teeth (mean)		3.0	4.5	3.8	0.001
	Presence of periodontal pocket depth over 4 mm	no yes	171 8	142 50	313 58	0.000
Situation at the last visit	Age (mean)		60.0	74.7	67.5	0.001
	Mean length of maintenance care (year)		27.5	25.8	26.6	0.933
	Number of present teeth (mean)		25.4	21.6	23.4	0.000
	Smoking	no yes	169 10	175 17	344 27	0.238
	Diabetes Mellitus	no yes	171 8	179 13	350 21	0.376
	Circulatory disease	no yes	152 27	126 66	278 93	0.000
	Disease of intestinal organ	no yes	163 16	164 28	327 44	0.109
	Annual tooth loss	male *	0.040	0.127	0.086	0.000
		female *	0.040	0.108	0.075	0.000
		total	0.040	0.115	0.079	

*Difference of annual tooth loss between male and female was not significant.

also showed that the number of non-vital teeth, the presence of periodontal pocket depth over 4 mm at the base line, as well as smoking and diabetes mellitus at the last visit, were significantly related to the annual tooth loss during the maintenance

period, for the older group (Table 6).

Discussion

The subjects of the present research were not chosen by random sampling from the general

Table 5 Annual tooth loss during maintenance period by health status for two age groups

			Age at the base line					
			Less than 40 years old			40 years old and more		
			n	annual tooth loss	p-value	n	annual tooth loss	p-value
General situation	Period of maintenance	15~20	16	0.032	0.359	25	0.126	0.704
		21~25	44	0.027		63	0.126	
		26~30	50	0.036		52	0.095	
		31~36	69	0.053		52	0.116	
	Age at evaluation	35~49	24	0.004	0.001	—	—	0.133
		50~59	60	0.020		2	0.100	
		60~69	69	0.065		50	0.081	
		70~79	26	0.051		96	0.116	
		80~	—	—		44	0.152	
Oral health situation at the base line	Number of present teeth	0~20	9	0.189	0.000	30	0.187	0.000
		21~25	40	0.043		79	0.142	
		26~28	130	0.029		83	0.063	
	Number of filled teeth	0~1	23	0.086	0.029	55	0.152	0.131
		2~4	34	0.034		70	0.102	
		5~7	55	0.033		44	0.110	
		8+	67	0.032		23	0.077	
	Number of vital teeth with crown	0	57	0.025	0.200	34	0.085	0.485
		1~2	42	0.038		46	0.106	
		3~4	39	0.043		48	0.125	
		5+	41	0.059		64	0.129	
	Number of non-vital teeth	0~1	77	0.018	0.005	57	0.101	0.032
		2~3	42	0.057		47	0.083	
		4~7	41	0.048		54	0.119	
		8+	19	0.076		34	0.176	
	Presence of periodontal pocket depth over 4 mm	no	171	0.035	0.000	142	0.080	0.000
		yes	8	0.140		50	0.213	
History situation at the last visit	Smoking	no	169	0.040	0.926	175	0.106	0.006
		yes	10	0.042		17	0.208	
	Diabetes Mellitus	no	171	0.038	0.133	179	0.107	0.004
		yes	8	0.081		13	0.228	
	Circulatory disease	no	152	0.040	0.939	126	0.115	0.976
		yes	27	0.039		66	0.114	
	Disease of intestinal organ	no	163	0.040	0.986	164	0.115	0.925
		yes	16	0.040		28	0.112	

Table 6 Multiple regression equation for annual teeth loss and beta for each independent

		Coefficient value	Beta	t-value	Significance
Less than 40 years old	Age at the last visit	0.0013	0.1538	1.5805	0.1159
	Mean years of maintenance	0.0006	0.0392	0.4262	0.6705
	Number of present teeth *	-0.0078	-0.2957	-3.3513	0.0010
	Number of filled teeth *	-0.0005	-0.0252	-0.3350	0.7380
	Number of vital teeth with crown *	-0.0026	-0.0894	-1.1228	0.2631
	Number of non-vital teeth *	0.0023	0.0966	1.2714	0.2053
	Presence of periodontal pocket depth over 4 mm *	0.0655	0.1722	2.3757	0.0186
	Smoking	-0.0099	-0.0289	-0.4175	0.6769
	Diabetes Mellitus	0.0291	0.0766	1.1051	0.2707
	Constant	0.1457			
40 years old and more	Multiple R	0.4773			
	Adjusted R ²	0.2278			
	Age at the last visit	0.0024	0.1128	1.4928	0.1372
	Mean year of maintenance	-0.0013	-0.0479	-0.6558	0.5128
	Number of present teeth *	-0.0042	-0.1198	-1.6838	0.0939
	Number of filled teeth *	0.0008	0.0184	0.2615	0.7940
	Number of vital teeth with crown *	0.0027	0.0624	0.9120	0.3630
	Number of non-vital teeth *	0.0056	0.1685	2.5581	0.0113
	Presence of periodontal pocket depth over 4 mm *	0.1184	0.3562	5.5123	0.0000
	Smoking	0.0823	0.1601	2.5111	0.0129
	Diabetes Mellitus	0.1006	0.1732	2.7582	0.0064
	Constant	-0.0109			
	Multiple R	0.5426			
	Adjusted R ²	0.2944			

* at the base line

population, but were a cohort who have received long term maintenance care at dental clinics. Therefore, they might have been motivated for oral cleaning self care by their comparatively high health care awareness. However, results obtained from a highly motivated population may show fundamental factors relevant to the general population. Moreover, the results during the maintenance period may show practitioners the important factors in the prevention of tooth loss of the patients under their intensive care.

During maintenance care, some have dropped out from the regular plan, and so those who did not participate in the maintenance care and those who

dropped out of the maintenance care were excluded from our research sample. Those who moved away, retired or died before the evaluation, were included in the dropping out group.

From the result of multiple regression analysis, the presence of periodontal pocket depth over 4 mm at the base line seemed to increase annual tooth loss during the maintenance period, for both the older and younger age groups. The number of teeth present at the baseline was related to tooth loss only for the younger age group. Whereas the number of non-vital teeth, smoking habit and diabetes mellitus was significant related to the annual tooth loss for the older group, there was no such relationship for

the younger group. These results show, that even in the younger generation as well as in older generation, the more teeth with periodontal pockets they retain, the more likely they are to lose teeth even under professional maintenance care. It was also indicated that the more non-vital teeth they retain, the more teeth they may lose in later years. For those aged 40 and more, other factors which affect general health also related to tooth loss. That suggests that general health guidance on smoking and prevention of diabetes mellitus might be more important during maintenance care by dental practitioners for elderly people.

Hirschfeld and Wasserman²¹⁾, McFall²²⁾, Lindhe and Nyman²³⁾, Goldman *et al.*²⁴⁾, Nabers *et al.*²⁵⁾, Wood *et al.*²⁶⁾, and Axelsson *et al.*²⁷⁾ presented the results of surveys on tooth mortality in relation to maintenance care through regular dental visits. Papapanou *et al.*²⁸⁾, Niessen and Weyant²⁹⁾, and Chauncey *et al.*³⁰⁾ have reported on tooth mortality in the absence of maintenance care. According to these surveys, the mean number of teeth lost annually under maintenance care ranged from 0.013²⁷⁾ to 0.17²⁴⁾, while the range was 0.32²⁸⁾ to 0.47²⁹⁾ in the absence of maintenance or preventive treatment. Axelsson *et al.*³¹⁾ also monitored the incidence of tooth loss of the patients who received periodic preventive maintenance at a private office during a 30-year period. According to their study, calculated annual loss of teeth among individuals aged 36 to 50 years at their first visit was 0.02, while it was 0.06 among those aged 51 to 65 years. In our study, during maintenance care for 31 years, the annual loss of those starting maintenance care at the age of less than 40 years was 0.053, while it was 0.116 among those starting maintenance care over the age of 40.

Furthermore, other research clarified that the combination of early diagnosis and treatment with a proper preventive program, performed by a dentist or a dental hygienist (including plaque disclosure, professional teeth cleaning, and the use of a fluoride-

continuing dentifrice/paste), effectively reduced the rate of tooth loss³²⁾, and multiple sources have indicated that long-term periodic dental maintenance is important for the prevention of dental disease as well as tooth loss^{33~37)}.

The implication that tooth loss more likely occurred with non-vital teeth, suggests a practical guideline of keeping teeth out of pulpectomy for preventing tooth loss in the later years. Axelsson *et al.*³¹⁾ stated that the main reason for tooth loss under continuing professional care was root fracture. It can be suggested that many fractured non-vital teeth tended to be extracted during maintenance care, although the present study did not make any detailed analysis of the cause of tooth loss. The two clinics in the present study do not provide removal of dental pulp expediently and perform it only when necessary, as for crown restoration. It can be proposed that periodic maintenance program both facilitating discovery of caries at an early stage and also preventing dental pulp infection, may reduce the overall rate of tooth loss.

We would suggest that dental practitioners should be aware of the relationship between general health and oral health in order to keep teeth of the elderly longer through maintenance care.

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歯科診療所における長期メンテナンス中の中高年期の 歯の喪失に関連する要因

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抄録: 本研究の目的は、歯科診療所において長期間のメインテナンスケアを利用して
いる、中高年期の受診者の歯の喪失に関連する危険因子を明らかにすることである。

大阪市内の2つの歯科医院のいずれかにおいて、15年間以上メンテナンスを受け、
かつ2004年7月~10月の4カ月間に来院した者のすべてを対象とした。対象者の1年
あたり喪失歯数は、初期治療終了後の1回目のメンテナンス受診開始時（ベースライ
ン時）と、上記期間最終の来院時の歯の本数の差により算出した。

最終来院時の対象者平均年齢は67.5歳で、対象者371人の平均メンテナンス期間
は、ベースライン時年齢が40歳未満は27.5年間、40歳以上は25.8年間であった。

第三大臼歯を除く、年平均喪失歯数は40歳未満が0.040本、40歳以上が0.115本で
あった。重回帰分析の結果、ベースライン時年齢が40歳未満は、現在歯数が少ないこ
とと4mm以上の歯周ポケットの有無が年喪失歯数との関連が示された。一方、ベース
ライン時年齢が40歳以上は、失活歯数、4mm以上の歯周ポケットの有無、および糖
尿病の有無と喫煙習慣が年喪失歯数との関連が示された。本研究の結果、長期メインテ
ナンスを継続的に実施する場合でも、40歳以降の受診者については歯周病だけではなく、
喫煙習慣および糖尿病などの健康管理に配慮するとともに、生涯を通じて歯髓の失
活を防ぐことが中高年期における歯の喪失の予防に重要であることを示唆している。

キーワード: 長期メンテナンス, 平均喪失歯数, 現在歯数, 失活歯数

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