

Relationships between patient characteristics and reasons for tooth extraction in Japan

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Objectives: The purpose of this study was to examine the relationships between patient characteristics and reasons for extraction of permanent teeth. **Methods:** 5,131 dentists were selected from the list of the membership directory of the Japan Dental Association by systematic random selection. The dentists were asked to record the reason for each extraction of permanent teeth during a period from February 1 to 7, 2005. Reasons for tooth extraction were assigned to five groups: caries, fracture of teeth weakened by caries or endodontics, periodontal diseases, orthodontics and other reasons. We used cross tabulation and multiple logistic regression analysis to estimate the relationships between patient characteristics and reasons for tooth extraction. **Results:** 2,001 dentists (response rate of 39.0%) returned the forms, and complete information on 7,333 patients was obtained. A total of 3,196 (43.6%) patients underwent tooth extraction due to caries and its sequela, and 2,721 (37.1%) patients underwent tooth extraction due to periodontal disease. Multiple logistic regression analysis showed that denture wearers were more likely to undergo tooth extraction due to periodontal disease in all age groups ($p < 0.05$). Males tended to undergo tooth extraction due to periodontal disease than did females in all age groups ($p < 0.05$) except for age group 30–49. Subjects with 19 or less teeth were more likely to undergo tooth extraction due to periodontal disease in the age groups 30–49 ($p < 0.001$) and 50–69 ($p < 0.001$). In the age group of 50 years or older, female ($p < 0.01$) and the possession of 20 or more natural teeth ($p < 0.05$) were related to caries extraction. However, there was no clear relationship between caries extraction and patient characteristics under 50 years old. **Conclusion:** There was a significant relationship between denture wearing and periodontal extraction. In the middle aged population, patients with 19 or less teeth lost their teeth mainly due to periodontal disease.

Key words: Dental caries; periodontal disease, tooth extraction

Introduction

WHO set oral health goals, objectives and targets in Global Goals for Oral Health 2020 (Hobdell *et al.*, 2003). One of the targets regarding tooth loss is to increase the number of individuals with functional dentitions (21 or more natural teeth) by X% at ages of 35–44 and 65–74 years. The goal “X%” should be established on the basis of local circumstances. In Japan, an increase in the number of individuals with 20 teeth at the age of 80 years is also one of the oral health targets. Information on the reasons for extraction of permanent teeth and characteristics of patients is required to organize and implement appropriate public health strategies for prevention and treatment of oral disease.

Nationwide surveys to determine the reasons for tooth extractions have been carried out in many industrialized countries (Cahen *et al.*, 1985; Reich and Hiller, 1993; Ong *et al.*, 1996; Murray *et al.*, 1996; Angelillo *et al.*, 1996; Trovik *et al.*, 2000; Agerholm, 2001; McCaul *et al.*, 2001; Quteish, 2003). Dental caries is generally the main cause of tooth loss in young people, whereas periodontal disease is the main cause of tooth loss in middle-aged and elderly people. In most of the past studies on reasons for tooth extraction, an individual tooth has been used

as the unit of analysis. However, multiple teeth are often extracted in a subject with severe periodontal disease (Phipps and Stevens, 1995). As a result, large numbers of teeth extracted due to periodontal disease in a relatively small number of patients might skew the results (Burt and Eklund, 2005). Phipps and Stevens (1995) reported that 51% of teeth were extracted because of periodontal disease and 35.4% were extracted because of caries. On the other hand, when using patients as the unit of analysis, 58% of patients had extraction for caries and 40% had extraction for periodontal disease. Therefore, it might be more important to use one patient as a unit of analysis (individual-based study) than using one tooth (tooth-based study).

Oral checkup to detect periodontal disease for adults of 40 years of age or over is recommended in a public health service in Japan, while service to detect dental caries in these people has not been implemented. However, natural consequence of aging does not cause severe periodontal disease that leads to tooth loss, and it has been shown that only a small percentage of people (5–15%) exhibit severe periodontal disease (Løe *et al.*, 1986; Burt, 1994; Locker *et al.*, 1998). In order to plan adequate dental public health services, it is essential to know the relationship between patient characteristics and reasons for

tooth loss. The aim of this epidemiological study was to determine the relationships of patient characteristics such as age, gender, number of remaining teeth, and denture usage with reasons for tooth extraction.

Materials and methods

A list of general dental practitioners in Japan was obtained from the 2004 membership directory of the Japan Dental Association. This directory included 57,989 dentists in all prefectures of Japan. Therefore, this study is considered as a nationwide study. Based on the previous study in Japan (Morita *et al.*, 1994), we assumed that participation of 5,000 dentists is required. Every tenth dentist on the list was selected for the study population. The names of the dentists were not listed at regular intervals in this membership directory. Dentists who had participated in other national surveys were excluded. Finally, a total of 5,131 dentists were selected from general dental practitioners in Japan. They were sent a data collection form with a covering letter requesting that the dentist complete the form every time extraction of one or more permanent teeth was carried out during one working week in February 2005. The dentists were asked to record the tooth type extracted and the reason for tooth extraction, referring to criteria given in the form. The questionnaire consisted of the following parts: 1. age and gender of the patient, 2. number of remaining teeth before the extraction, 3. reason for the extraction, and 4. presence or absence of removable partial denture. The reason for each tooth extraction was assigned to one of these categories: caries, fracture of teeth weakened by caries or endodontics, periodontal disease, orthodontics and others including third molar extractions, prosthetic reasons etc.

The unit of analysis was a patient, not a tooth. For example, if a patient received only one tooth extraction due to caries, he/she was classified as "caries". If two or more teeth were extracted for different reasons, the patient was classified as "multiple reasons". Completed questionnaires were coded and data analysis was performed using the Stata 8.0 program. Multiple logistic regression analyses stratified by age were used to identify patient characteristics that were independently associated with reason for tooth extraction. The independent variables of these analyses were patient characteristics. In the multiple logistic regression analysis, we classified the patients into those who underwent extraction because of dental caries or fracture, or those who underwent extraction because of periodontal disease, orthodontics or others, for dependant variable. For dependant variable in the other multiple logistic analysis, we classified patients into those who underwent extraction because of periodontal disease, or those who underwent extraction because of dental caries, fracture, orthodontics or others. To screen for multicollinearity, all variables were checked using Spearman's rank correlation. There was no strong multicollinearity (as determined by $|\rho| \geq 0.7$) among the variables collected.

Results

A total of 2,001 dentists responded (recovery rate of 39.0%). There was no statistically significant difference

between the gender distributions of respondents and the population (all members of the Japanese Dental Association). The mean ages of the respondents and the population were 50.7 (SD= 9.4) years and 51.1 years, respectively. The mean numbers of dentists and dental hygienists were 1.3 (SD= 0.8) and 1.5 (SD= 1.4) in the respondents and 1.26 and 0.92 in the population group. The respondents treated about 24 patients every day, and their mean working hours were eight hours per day. The mean age of the patients was 53.7 (SD= 17.5) years.

The reasons for tooth extraction according to gender of the patients are shown in Table 1. Tooth extraction was performed in 7,333 patients, including 3,646 males and 3,687 females. The age of the patient ranged from eight to 96 years old. Tooth extraction was performed in 3,196 (43.6%) of the patients due to caries (32.1%) or fracture (11.5%), and in 2,721 (37.1%) of the patients due to periodontal disease. Tooth extraction was performed in only 2.9% of the patients due to multiple reasons and in only 1.3% of the patients due to orthodontics. Reasons given in the "other reasons" group (15%) were extractions of 3rd molars and prosthetic reasons. Tooth extraction due to periodontal disease was performed in a higher percentage of males (41.4%) than females (32.8%).

Table 2 shows the reasons for tooth extraction in patients with ≥ 20 teeth or ≤ 19 teeth and in patients with or without removable partial dentures. Caries or its sequela (fracture) were the most predominant reasons for tooth extraction in patients with 20 or more teeth (47.3%) or in non-denture wearers (47.1%), while periodontal disease was the predominant reason in patients with 19 or less teeth (54.6%) or in removable denture wearers (54.6%).

Fig.1. shows the distribution of reasons for tooth extraction and the percentage of patients with 19 or less teeth according to age group. Caries and fracture were the most frequent reasons in the age groups 15-24 to 45-54. Periodontal disease was the most frequent reason in the age groups 55-64 and more. The number of patients who underwent tooth extraction due to periodontal disease and the number of patients wearing partial dentures increased after middle age.

Fig. 2. shows the relationship between reasons for tooth extraction in various age groups and number of remaining teeth. The patterns of the reasons for tooth extraction were different for patients with 19 teeth or less (Fig. 2a) and those with 20 teeth or more (Fig. 2b). The main reason for tooth extraction in patients with 19 or less teeth in the age groups of 45-74 years was periodontal disease (Fig. 2a). In patients with 20 or more teeth, caries and fracture were the main reasons for tooth extraction in all age groups between 25-74 years (Fig. 2b).

Multiple logistic regression analyses stratified by age were performed using the reasons for tooth extraction (caries or fracture/periodontal disease) as dependent variables (Table 3). Denture wearers were more likely to undergo tooth extraction due to periodontal disease in all age groups ($p < 0.05$). Males were more likely to have a tooth extracted due to periodontal disease than did females in all age groups ($p < 0.05$) except for the age group 30-49. Subjects with 19 or less teeth were more likely to undergo tooth extraction due to periodontal disease in the age groups 30-49 ($p < 0.001$) and 50-69

Table 1. Reasons for tooth extraction according to gender

	<i>Reasons for tooth extraction</i>						<i>Total</i>
	<i>Caries</i>	<i>Fracture</i>	<i>Periodontal disease</i>	<i>Orthodontics</i>	<i>Multiple reasons</i>	<i>Others</i>	
Males	1137	380	1510	25	119	475	3646
%	31.2	10.4	41.4	0.7	3.3	13.0	100.0
Females	1216	463	1211	73	96	628	3687
%	33.0	12.6	32.8	2.0	2.6	17.0	100.0
Total	2353	843	2721	98	215	1103	7333
%	32.1	11.5	37.1	1.3	2.9	15.0	100.0

Table 2. Reasons for tooth extraction in patients with ≥ 20 teeth or ≤ 19 teeth and in patients with and without removable dentures

	Reasons for tooth extraction						
	Caries	Fracture	Periodontal disease	Orthodontics	Multiple reasons	Others	Total
n. of remaining teeth							
≥20	1697	561	1325	95	99	1001	4778
%	35.5	11.7	27.7	2.0	2.1	21.0	100.0
≤19	656	282	1396	3	116	102	2555
%	25.7	11.0	54.6	0.1	4.5	4.0	100.0
Removable dentures							
Non-wearers	1701	480	1248	98	122	986	4635
%	36.7	10.4	26.9	2.1	2.6	21.3	100.0
Wearers	652	363	1473	0	93	117	2698
%	24.2	13.5	54.6	0.0	3.4	4.3	100.0
Total	2353	843	2721	98	215	1103	7333
	32.1	11.5	37.1	1.3	2.9	15.0	100.0

($p < 0.001$). In the age group of 50 years or older, female ($p < 0.01$) and the possession of 20 or more teeth ($p < 0.05$) were related to caries extraction. However, there was no clear relationship between caries extraction and patient characteristics in those under 50 years old.

Discussion

There are several limitations when interpreting the data. First, the response rate in our study (39%) was not so high compared to the study by Klock & Haugejorden (1993) (70%). The reinforcement of participation, i.e., asking by telephone or mail, might have increased the response rate. However, we could not carry out these efforts because of financial problems and limited manpower. Secondly, there were differences between responders and population on some variables. The mean number of dental hygienists employed by the respondents was higher than that in the population. It is possible that only dentists working with sufficient numbers of co-dental staff responded to our questionnaire. A significantly negative correlation was observed between number of members in Japan Dental Association and response rate in each prefecture ($r = -0.46$, $p < 0.001$). Therefore, dentists living in urban areas possibly did not respond more so than did

those in rural areas. Contributions of sociodemographic factors to tooth extraction have been reported (Bouma *et al*, 1987; Klock & Haugejorden, 1993). Klock & Haugejorden (1993) collected information about reasons for tooth extraction to determine whether dentist-associated characteristics influenced the relative emphasis on clinical diagnosis versus non-disease considerations as reasons for extraction. They found that dentists who practiced in communities with more than 10,000 inhabitants tended to give non-disease considerations as reason more often than dentists practicing in communities with less than 10,000 inhabitants. The differences in response rate between rural areas and urban areas might have biased our result. Third, the 2004 membership directory included 57,989 dentists in all prefectures of Japan. However, they covered 61% of the total dentists in 2004. The non-members of the Japan Dental Association did not participate in the present study. Since we could not get the lists of all the Japanese dentists, it was not possible to include a sample of this study. It is possible that these sampling biases may have influenced the results.

In most previous epidemiological studies on tooth extraction, the unit of analysis was a tooth (tooth-based analysis), not a patient (patient-based analysis). Tooth-based analysis enables elucidation the actual extent of

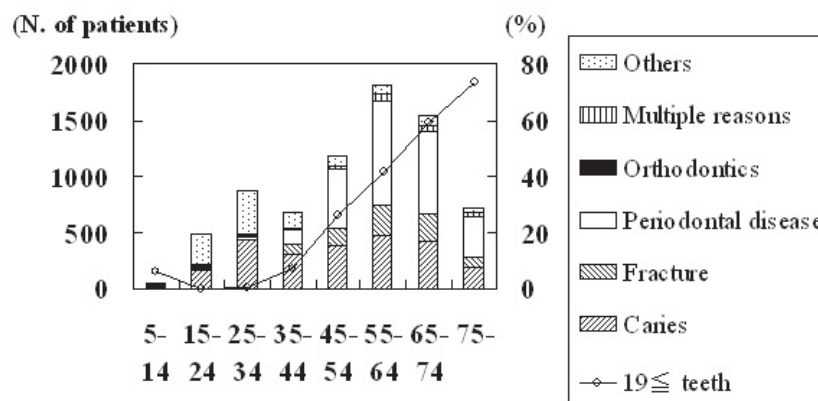


Figure 1. Distribution of reasons for tooth extraction and percentage of patients with 19 or less teeth according to age group ($n=7,333$)

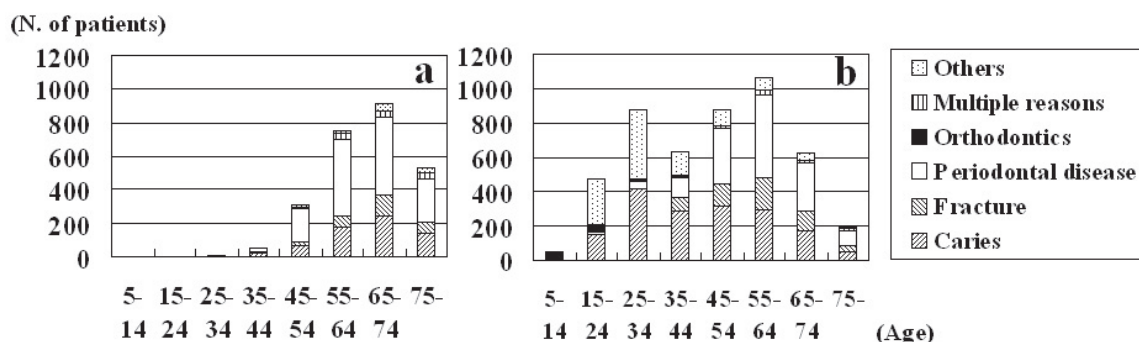


Figure 2. Reasons for tooth extraction according to age group. Patients with 19 or less teeth (a) ($n=2,555$) and patients with 20 or more teeth (b) ($n=4,778$)

the disease responsible for tooth extraction, whereas patient-based analysis enable elucidation of individual factors related to the reason for tooth extraction. As a result of logistic regression analysis, denture wearing was significantly related to the tooth extraction for periodontal disease after controlling age, gender and number of remaining teeth.

Partial denture wearers experienced tooth loss due to periodontal disease more frequently than non-denture wearers. Removable partial denture (RPD) has been shown to be one of the factors predisposing to plaque accumulation (Bates and Addy, 1978; Petridis and Hempton, 2001; Zlataric *et al.*, 2002). Zlataric *et al.* (2002) surveyed 205 patients with RPDs and periodontal disease in a cross-sectional study. Abutment teeth of RPDs showed the worse condition of periodontium. A review showed that wearing RPDs leads to detrimental qualitative and quantitative changes in plaque (Petridis and Hempton, 2001). However, it was concluded in that review that properly designed and maintained RPDs could provide long-term clinical benefit without any detrimental effects on the periodontal condition. Appropriate prosthetic maintenance is essential to achieve a good long-term prognosis.

One of the targets regarding tooth loss in the Global Goals for Oral Health 2020 (Hobdell *et al.*, 2003) is an increase in the number of individuals with functional dentitions (21 or more natural teeth) by X% at ages of

35-44 and 65-74 years. The Japanese government policy aims to achieve 20% of elderly at the age of 80 years have 20 teeth or more in 2010. The national survey showed the proportion of people with 20 or more teeth in age group 80 - 84 was 13.0% in 1999 (Ministry of Health, Labour and Welfare, Japan, 2001). Since the prevalence and extent of periodontal diseases increase with increasing age, oral checkup to detect periodontal disease for adults is recommended as a public health service in Japan. However, our results showed that caries and its sequela were the main reasons for tooth loss in patients with 20 or more teeth in the middle age groups (Table 2, Fig. 2). It suggested that public effort for caries prevention is still required to achieve WHO goals.

Phipps and Stevens (1995) reported that 58% of patients had experienced tooth extraction due to caries and that 40% had experienced tooth extraction due to periodontal disease. Results of analysis using a patient as a unit of analysis in our study showed that 43.6% of the patients underwent extraction due to caries and 37.1% underwent extraction due to periodontal disease (Table 1). The difference between these two percentages in our study was smaller than that in the study by Phipps and Stevens (1995). They used the one-year insurance records of 1,877 patients. On the other hand, our study period was only one week. Therefore, it is possible that a longer study period will give similar results. Another reason for the difference between the study by Phipps &

Table 3. Results of logistic regression analyses for reasons for tooth extraction. Dependent variables were caries/fracture and periodontal disease

Age group	Variable	Category	Odds Ratio	p-value	Odds Ratio	p-value
			Dependent variable: Caries or fracture		Dependent variable: Periodontal disease	
70 and more (n=1434)	Gender	Male	1		1	
		Female	1.36	P=0.005	0.76	p=0.012
	Age	Non-use	0.99	P=0.180	1.01	p=0.328
		Use	1		1	
	Partial denture	Non-use	0.83	P=0.181	1.43	p=0.009
		Use	1		1	
50-69 (n= 3356)	Gender	Male	1		1	
		Female	1.52	P<0.001	0.64	p<0.001
	Age	Non-use	1.01	P=0.188	0.99	p=0.044
		Use	1		1	
	Partial denture	Non-use	0.76	P=0.001	1.47	p<0.001
		Use	1		1	
30-49 (n= 1581)	Gender	Male	1		1	
		Female	1.05	P=0.631	0.80	p=0.086
	Age	Non-use	1.00	P=0.955	1.14	p<0.001
		Use	1		1	
	Partial denture	Non-use	0.73	P=0.133	2.20	p<0.001
		Use	1		1	
less than 30 (n= 962)	Gender	Male	1		1	
		Female	0.53	P<0.001	0.41	p=0.045
	Age	Non-use	1.12	P<0.001	1.03	p=0.545
		Use	1		1	
	Partial denture	Non-use	0.40	P=0.418	10.02	p=0.046
		Use	1		1	
	Number of remaining teeth	20≥	1		1	
		19≤	0.00	P=0.535	0.03	p=0.828

Stevens (1995) and our study might be due to the differences of age of patients. Their study included only the patients aged 40-69 years. Whereas, the age of patients in our study ranged from 8 to 96.

In the present study, dentists selected only one reason for a tooth extraction, although some patients might have had teeth extracted for different reasons (Klock & Haugejorden, 1993). Forcing dentist to give only the main reason for extraction of a tooth may have biased the result. However, the present study was based on the individual patient, not on an individual tooth. When a patient had two or more teeth extracted with two or more reasons for each tooth, the analytical procedure and the results would be confusing.

In conclusion, 43.6% of the patients underwent extraction due to caries and 37.1% underwent extraction due to periodontal disease. There was a significant relationship between denture wearing and periodontal extraction. In the middle aged population, patients with 19 or less teeth lost their teeth due to periodontal disease. In the age group of 50 years or older, female and the possession of 20 or more natural teeth were related to caries extraction.

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