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ORIGINAL ARTICLE

Factors affecting the oral condition of patients with severe motor and intellectual disabilities

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BACKGROUND: Handicapped persons living in nursing homes have special risks for oral diseases.
OBJECTIVE: To investigate the specific factors related to the occurrence of dental caries and tooth extraction in patients with severe motor and intellectual disabilities (PSMI) residing in an institution.
METHODS: One hundred eighty-nine PSMI residing in a single institution in Japan were followed for 3 years. Oral examinations were conducted at baseline and 3 years later. The following items were investigated: age of subject at admission, period of institutionalization, age at baseline oral examination, status of rumination, drooling, type of ward, dietary mode, and etiology of the impairment. Logistic regression analyses were conducted to examine factors associated with new dental caries and tooth extraction occurring during the study period.
RESULTS: By multivariate analysis, rumination and tube feeding were identified as significant factors associated with new dental caries. On the other hand, infancy or childhood impairment and drooling were identified as significant factors related to tooth extraction.
CONCLUSION: Some specific factors in this patient population affect the dental caries and tooth extraction and oral programs targeting these factors may reduce dental degeneration in these patients.
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Keywords: severe motor and intellectual disabilities; dental caries; tooth extraction; risk factor; logistic regression analysis

Terminology: Medical ward: a hospital ward for patients who need specialized medical care such as tracheotomy; Regular ward: a hospital ward for patients who do not need specialized medical care; Rumination: an eating disorder characterized by having the contents of the stomach drawn back up into the mouth, chewed for a second time, and swallowed again; Drooling: uncontrolled outflow of saliva from the mouth.

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Introduction

Patients with severe motor and intellectual disabilities (PSMI) are defined as those who have severe superimposing motor and intellectual disabilities as a result of disturbance of the central nervous system at the prenatal, perinatal, or infant period. No major survey or statistics of PSMI in Japan has been documented, and the real number of these patients remains unclear. A survey conducted in one prefecture in Japan has estimated that the proportion of PSMI in the population is 0.0297%; thus the total number is estimated to be around 38 000 in Japan (Japanese Severely Handicapped Children Welfare Association, 2000).

All PSMI have severe motor disabilities. Therefore they require care for activities of daily living including meal taking. It has been reported that 67.8% of the PSMI (25 551 patients) are living at home and are receiving care from their families and care facilities in the community (Japanese Severely Handicapped Children Welfare Association, 2000). Some community care facilities provide dental care for handicapped persons. Local health centers and dental clinics for the handicapped at dental hospitals, especially in university hospitals, also provide dental treatment and examinations for PSMI.

A previous study in Japan found that PSMI had many untreated and few treated dental caries (Kawaguchi and Nakajima, 1990). However, with the recent increase in the number of local facilities that provide dental treatment for handicapped persons, dental care has become more accessible for PSMI living in the community. Furthermore, as these facilities also provide regular examinations and preventive treatment, the oral conditions of PSMI have improved gradually, especially

in younger children (Asada *et al*, 2005). However, the dental clinic attendance rate decreases with aging, resulting in an increase in untreated dental caries, periodontal disease, and missing teeth. The oral condition of elderly handicapped persons apparently has not improved (Asada *et al*, 2005).

Severely handicapped persons who cannot be cared for at home are institutionalized in facilities where medical and social services are provided. According to a survey in 2000 (Japanese Severely Handicapped Children Welfare Association, 2000), a total of 181 such institutions were covered and approximately 12 000 patients were institutionalized. Among these institutions, 91 were public facilities. In 82 of these 91 public institutions (90.1%), dentists were in charge of the oral care for the residents (Japanese Severely Handicapped Children Welfare Association, 2000).

Even for the handicapped persons residing in institutions that provide dental care, many are found to have several untreated dental caries at the time of admission. However, untreated dental caries would have decreased if these patients sought dental treatment and regular examinations. While examinations and treatment are efficient in reducing the prevalence of untreated dental caries in the general population (Nomura *et al*, 1996), severely handicapped patients have specific problems and risks of oral disease.

Studies have suggested that the diet, or the frequency of sucrose intake, is an important factor for the incidence of dental caries (Sheiham, 2001; Ruottinen *et al*, 2004). Residents in institutions take controlled meals and undergo mouth cleaning either by themselves or assisted by caregivers after meals. However, even under such a controlled environment, some patients develop new dental caries very frequently and the incidence of new dental caries ranges widely. For PSMI, the existence of a specific oral environment may be related to the incidence of oral diseases. We conducted a 3-year follow-up study to investigate the specific factors that may be related to the incidence of dental caries and tooth extraction in PSMI residing in an institution.

Patients and methods

Study population

Patients with severe motor and intellectual disabilities residing in a public institution located in Fuchu City in the suburbs of Tokyo were studied. Patients who had undertaken oral examinations between 1999 and 2000, and then followed up for 3 years were included in the analysis. A total of 189 patients (90 men and 99 women) with a mean age of 40.1 ± 22.1 (age range: 8–75) years were analyzed. In the present cohort, the mean age of admission to this institution was 15.9 years and the mean age at receiving the baseline dental examination was 40.9 years. The period of residence in the center ranged from 1 to 31 years. The oral care of these PSMI consisted of the nurse brushing patients' teeth without toothpaste, after regular meals, while seated in their wheelchairs.

Oral examination

Oral examinations were conducted by two dentists under a light with dental probe, and exploration was conducted if necessary. The patients sat in a reclining wheel chair and the back-rest of the chair was reclined. Dental caries reaching the dentin were recorded for each surface of the tooth. The third molars were included in recording the number of remaining teeth; however, absence of the third molars was not counted as missing teeth.

Items investigated

In this study, the following parameters were investigated: age of the subjects, period of institutionalization, age at baseline oral examination, status of rumination, drooling, type of ward, dietary mode, and etiology of the impairment. The type of ward was classified into regular ward and medical treatment ward. The etiology of disabilities was classified into three groups: prenatal impairment (34.9% of all subjects analyzed), perinatal impairment (31.2%), and infancy and childhood impairment (33.9%). Prenatal impairments included etiologies of infection, intoxication, metabolic diseases, diseases of the parent, and chromosomal abnormalities. Perinatal impairments included those that occurred at birth or in neonatal stage, such as abnormal delivery. Infancy or early childhood impairments included etiologies of injuries or symptomatic syndromes. Before the survey, we confirmed that there was no difference in the distribution of etiologies in the medical and regular wards in this institution. The meals provided were classified by the ability of the patient's masticatory or swallowing functions. In the regular meal group, patients with normal masticatory function were provided regular or diced food. In the mashed meal group, patients with disability in masticatory function were provided mashed meal or paste-like food. In the tube feeding group, patients with disability in swallowing function were fed by tubes. The changes in number of decayed, missing, filled teeth (DMFT) were evaluated by the Wilcoxon's signed rank test.

Statistical analysis

Before analysis, the patients were classified into two groups: with and without new dental caries, or with and without treatment by tooth extraction. Cross tabulations were constructed with the groups described above for each risk factor. The *P*-values were calculated by Fisher's exact test. The Mann–Whitney *U*-test was used to analyze categorical variables. Logistic regression analysis was conducted to calculate the odds ratios for each risk factor. Multivariate adjusted logistic regression analysis was then conducted to exclude the confounding effects. These analyses were performed using the SPSS software (SPSS, Tokyo, Japan).

Results

In this study, 40 patients had new dental caries and 23 had tooth extraction during the 3 year follow-up period. Seventeen patients had one new dental caries and one

patient had 14 new caries, which was the maximum in this series. Among patients with tooth extraction during the 3-year period, extraction of one tooth was most frequent (10 patients). Five patients had tooth fracture in one tooth. Four patients had detachment of filling in one tooth, and one patient in two teeth. Secondary caries were most frequent; involving one tooth in seven patients, two teeth in six, three teeth in five, four teeth in one, and 11 teeth in one. Eight patients were treated for interproximal caries in two teeth. Five patients had occlusal caries in one tooth, and three patients had cervical caries in one tooth.

The relationships between the risk factors and the presence or absence of dental caries or tooth extraction are shown in Table 1 for the categorical variables and in Table 2 for the continuous variables. Table 2 shows the changes in number of remaining teeth, treated teeth, missing teeth and DMFT from baseline to 3 years later. The numbers of remaining teeth, missing teeth and DMFT increased during the 3-year period. Although the number of treated teeth showed an apparent increase, the difference was not statistically significant.

The results indicated that patients with many fillings at baseline had a significantly higher probability of having new dental caries in 3 years. Patients with higher age at admission and those with many filled and missing teeth had a significantly higher probability of having tooth extraction during the follow-up period. The type of ward, etiology of disability, and drooling had no relationship to the occurrence of new dental caries or tooth extraction during the 3-year period. However, the type of diet and status of rumination were significantly related to new dental caries but not to tooth extraction.

Table 1 Characteristics of patients classified by the presence/absence of new dental caries, and by the presence/absence of tooth extractions during the 3-year follow-up period (categorical variables)

	Dental caries			*Tooth extraction*		
	−	+	P-*value*	−	+	P-*value*
Ward						
Regular ward ($n = 142$)	109	33	0.225	124	18	0.711
Medical ward ($n = 47$)	40	7		42	5	
Impairment						
Prenatal ($n = 66$)	52	14	0.990	62	4	0.060
Perinatal ($n = 60$)	47	13		53	7	
Infancy/childhood ($n = 63$)	50	13		51	12	
Diet style						
Regular meal ($n = 58$)	43	15	0.032	49	9	0.549
Mashed meal ($n = 94$)	71	23		83	11	
Feeding tube ($n = 37$)	35	2		34	3	
Rumination						
− ($n = 179$)	145	34	0.002	158	21	0.436
+ ($n = 10$)	4	6		8	2	
Drooling						
− ($n = 164$)	133	31	0.051	147	17	0.052
+ ($n = 25$)	16	9		19	6	
Total						
$n = 189$	149	40		166	23	

P-values were calculated by the Fisher's exact test.

The results of the logistic regression analysis for the factors associated with new dental caries and tooth extraction are shown in Tables 3 and 4, respectively. For new dental caries (Table 3), univariate analysis identified rumination, feeding tube, and number of treated teeth as significant factors. Multivariate analysis also identified rumination and tube feeding as important and significant factors, with adjusted odds ratios of 16.6 ($P = 0.006$) and 0.14 ($P = 0.036$), respectively, while the odds ratio for number of treated teeth was almost 1 ($P = 0.037$).

For tooth extraction (Table 4), univariate analysis identified infancy or childhood impairment, age at baseline, and number of treated teeth as significant risk factors. Multivariate analysis identified infancy or childhood impairment, drooling, age at baseline, and DMFT as significant factors. The odds ratios for infancy or childhood impairment and drooling were 4.66 ($P = 0.037$) and 3.87 ($P = 0.044$), respectively, while the odds ratios for age at baseline and DMFT approached unity. Rumination – a significant risk factor of new dental caries – was not significant for tooth extraction.

Discussion

In the present cohort, age at baseline dental examination was one of the risk factors for tooth extraction, but not for new dental caries. Piper *et al* (1986) indicated that in handicapped patients, tooth loss increased rapidly with advancing age. Another survey on adult patients with mental disabilities residing in nursing homes showed that the highest proportion of missing teeth was found in subjects older than 30 years when analyzed by DMFT components Vazquez *et al*, 2002). A possible reason is that destruction of periodontal tissue occurs earlier in handicapped persons than in healthy subjects, and disease progression may also be accelerated.

In this study, patients with more fillings at baseline had higher probabilities for future caries. Nomura *et al* (2006) and Russell *et al* (1991) reported that first caries experience had correlation with future incidence of new dental caries. Regarding oral care for the patients in this study, the nurses who had training from dental hygienists brushed their teeth after regular meals. Patient grimacing and spasticity of oral musculature limited the effectiveness of oral care procedures. In addition, fluoride toothpaste could not be used because they could not rinse out. These factors could make it difficult to improve the oral condition.

Medical wards accommodate patients who require tracheotomy. Other than this special care procedure, there is no difference in daily routine between the regular and medical wards. There was also no difference in distribution of PSMI etiology between the two types of wards (data not shown). In this study, the type of ward is not a significant risk factor for new dental caries and tooth extraction. This result indicates that respiratory disturbances and swallowing disorders may not affect these tooth conditions. In contrast, a previous report indicated that oral conditions in medical wards that

Table 2 Characteristics of patients classified by the presence/absence of new dental caries, and by the presence/absence of tooth extraction during the 3-year follow-up period

	Dental caries					*Tooth extraction*					*Total*		
	− (n = 149)		*+ (n = 40)*			*− (n = 166)*		*+ (n = 23)*			*(n = 189)*		
	Mean	*s.d.*	*Mean*	*s.d.*	P-*value*	*Mean*	*s.d.*	*Mean*	*s.d.*	P-*value*	*Mean*	*s.d.*	P-*value*
Age at admission	15.5	13.6	15.6	9.8	0.222	14.5	12.1	23.0	16.0	0.009	15.5	12.9	
Age at check-up	40.2	11.9	42.9	9.7	0.094	39.9	11.5	47.0	9.6	0.006	40.8	11.5	
Baseline													
No. remaining teeth	21.8	8.9	23.0	5.8	0.547	22.3	8.5	20.6	7.2	0.096	22.1	8.4	
No. filled teeth	3.5	4.1	6.0	4.7	0.001	3.6	4.2	7.2	4.3	<0.001	4.0	4.4	
No. missing teeth	6.1	8.6	5.4	5.5	0.167	5.7	8.2	8.3	6.8	0.010	6.0	8.0	
DMFT	9.3	9.2	11.2	8.0	0.080	8.9	8.9	15.5	7.5	<0.001	9.7	9.0	
Follow-up													
No. remaining teeth	20.9	9.5	22.9	6.0	0.170	21.8	9.0	17.8	7.1	<0.001	21.3	8.9	0.011
No. filled teeth	6.3	8.6	5.6	5.7	<0.001	5.5	8.0	11.0	6.9	0.001	6.2	8.1	0.239
No. missing teeth	3.6	4.5	6.8	4.6	0.029	3.9	4.6	6.9	4.6	<0.001	4.3	4.7	<0.001
DMFT	10.0	9.5	12.4	7.9	0.961	9.5	9.0	17.9	7.0	0.001	10.5	9.2	<0.001

Table 3 Results of the logistic regression analysis for new dental caries during the 3-year follow-up period

	Crude odds ratio	*95.0% CI*	P-*value*	*Adjusted odds ratio*	*95.0% CI*	P-*value*
Age at baseline	1.021	0.99–1.053	0.193	1.046	0.993–1.103	0.091
Medical ward/regular ward	0.578	0.237–1.411	0.229	2.502	0.722–8.672	0.148
Prenatal impairment	Reference		0.990	Reference		0.983
Perinatal impairment	1.027	0.438–2.408	0.950	1.097	0.408–2.946	0.855
Infant/childhood impairment	0.966	0.413–2.257	0.936	1.052	0.402–2.756	0.918
Regular meal	Reference		0.062	Reference		0.073
Mashed meal	0.929	0.437–1.971	0.847	0.997	0.412–2.416	0.995
Tube feeding	0.164	0.035–0.765	0.021	0.141	0.023–0.879	0.036
Rumination	6.397	1.71–23.926	0.006	16.630	2.234–123.799	0.006
Drooling	2.413	0.976–5.968	0.056	2.201	0.752–6.438	0.150
Number of remaining teeth	1.018	0.974–1.064	0.434	0.995	0.784–1.263	0.967
Number of treated teeth	1.126	1.044–1.215	0.002	1.101	1.006–1.206	0.037
Number of missing teeth	0.988	0.944–1.034	0.604	0.910	0.704–1.175	0.469

Table 4 Results of the logistic regression analysis for tooth extraction during the 3-year follow-up period

	Crude odds ratio	*95.0% CI*	P-*value*	*Adjusted odds ratio*	*95.0% CI*	P-*value*
Age at baseline	1.057	1.015–1.1	0.007	1.075	1.006–1.15	0.033
Medical ward/regular ward	0.820	0.287–2.345	0.711	3.414	0.617–18.906	0.160
Prenatal impairment	Reference		0.094	Reference		0.111
Perinatal impairment	2.047	0.568–7.378	0.273	2.756	0.595–12.773	0.195
Infancy/childhood impairment	3.647	1.109–11.997	0.033	4.664	1.097–19.832	0.037
Regular meal	Reference		0.556	Reference		0.781
Mashed meal	0.722	0.279–1.864	0.500	0.734	0.224–2.409	0.610
Feeding tube	0.480	0.121–1.906	0.297	0.522	0.076–3.566	0.507
Rumination	1.881	0.374–9.457	0.443	2.602	0.325–20.814	0.367
Drooling	2.731	0.959–7.774	0.060	3.873	1.035–14.496	0.044
Number of remaining teeth	0.978	0.932–1.027	0.370	1.627	1.076–2.459	0.021
Number of treated teeth	1.169	1.071–1.277	0.001	1.166	1.049–1.297	0.005
Number of missing teeth	1.036	0.987–1.086	0.152	1.673	1.086–2.578	0.020

accommodated patients with severe disabilities were worse when compared with the regular wards (Sugiyama and Sumita, 1999). The authors in that report suggested that for patients with severe disabilities, priority was given to medical treatment so that oral care was deferred. This may suggest that the most important factors for dental caries and tooth extraction are related to oral care rather than to the level of disability.

There was no significant correlation between diet style and the etiology of impairment ($P < 0.703$ by Fisher's exact test). From the results of logistic regression analyses, tube feeding had a remarkably lower odds ratio for new dental caries relative to regular meals (0.164 by univariate analysis, $P = 0.021$; 0.141 by multivariate analysis, $P = 0.036$), showing that it is a negative risk factor for dental caries. Dyment and Casas

(1999) have shown that the incidence of dental caries in patients who take their nutrients by feeding tube is low because the pH in the oral cavity does not decrease. Their evidence is consistent with our results. On the other hand, the type of diet was not a significant factor for tooth extraction.

Many nursing homes accommodating patients with cerebral palsy had problems with rumination as a risk factor for dental caries (van Lith, 1991; Bohmer *et al*, 1997; Gravestock, 2000). Rumination lowers the pH of the oral cavity to 1.5–2.0. In this study, the presence of rumination showed an odds ratio of 6.40 for new dental caries, relative to the absence of rumination. In contrast, rumination was not a significant risk factor for tooth extraction. This finding may indicate that the regular after-meal tooth brushing is effective to stop drastic tooth degeneration leading to extraction in ruminating patients, even though secondary caries cannot be prevented.

It has been suggested that drooling in patients with cerebral palsy is related to difficulties in swallowing rather than hypersalivation (Senner *et al*, 2004). In the present study, uncontrolled drooling may also be caused by difficulty in swallowing. The results in this study indicated that drooling was not a risk factor for dental caries. On the other hand, drooling was a significant risk factor for tooth extraction (univariate analysis: odds ratio 2.731, $P = 0.06$; multivariate analysis: odds ratio 3.873, $P = 0.044$). This may be related to other pathologic conditions specific to PSMI, including difficulties in swallowing, which were not analyzed in the present study. Indeed, another study demonstrated that patients with cerebral palsy who had undergone sialodochoplasty to control drooling had increased risk of dental caries after surgery (Hallett *et al*, 1995). This finding suggests that constant saliva flow may protect against dental caries by buffering the oral pH.

The present study identified rumination as an important risk factor for the development of dental caries, and drooling as an important risk factor for tooth extraction in PSMI residing in an institution that practices oral care on an institutional basis. These findings suggest that some factors specific to this patient population may precipitate dental degeneration. Oral programs targeting these factors may improve the dental condition in these patients and prevent caries and loss of teeth.

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