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—ORIGINAL ARTICLE—

## Dental status and mortality in institutionalized elderly people

by

Mitsuyoshi Yoshida,<sup>1</sup> Takeyoshi Yoneyama,<sup>1</sup> Toshifumi Matsui,<sup>1</sup> Mieko Adachi,<sup>1</sup> Takashi Ohrui,<sup>1</sup> Mei He,<sup>1</sup> Mutsuo Yamaya,<sup>1</sup> Hiroyuki Arai,<sup>2</sup> Hidetada Sasaki<sup>1</sup> and Members of the Oral Care Working Group

*<sup>1</sup>Department of Geriatric and Respiratory Medicine and <sup>2</sup>Department of Geriatric and Complementary Medicine, Tohoku University Graduate School of Medicine, Sendai 980-8574, Japan*

All correspondence should be sent to:

Takashi Ohrui, MD., PhD.

Department of Geriatric and Respiratory Medicine,

Tohoku University School of Medicine,

Sendai, 980-8574, Japan

Phone: +81-22-717-7182, Fax: +81-22-717-7186

E-mail address: [ohrui@geriat.med.tohoku.ac.jp](mailto:ohrui@geriat.med.tohoku.ac.jp)

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## **Abstract**

**Background:** Inadequate dentition for mastication is one of the major issues associated with systemic health for institutionalized elderly people, but its prognostic value and related deaths have not been fully examined.

**Methods:** Four hundred and three patients aged 65 and older were recruited from nine nursing homes and were prospectively followed-up for morbidity and mortality for 5 years in Japan. These patients were classified into 3 groups according to dental status: patients who had adequate dentition with natural teeth only or natural teeth with partial dentures (Group A); those who were edentulous but wearing full dentures (Group B); and those who had inadequate dentition without dentures (Group C).

**Results:** Dental status was strongly related to age, cognitive function and activities of daily living. After allowing for confounding effects, the 2-year risk of mortality among those in Group C was 1.84 times that of Group A (95% CI 1.01-3.36,  $P = 0.047$ ). Furthermore, the 5-year mortality rate in Group C was higher than that in Group A, whereas that was not significant with a hazard ratio of 1.30 (0.90-1.88,  $P = 0.168$ ). The main causes of death were respiratory infections, which explained 14.1% of all causes of death in Group A, 14.3% in Group B and 18.3% in Group C. Any associations between a specific cause of death and the different dental status did not reach a significant level.

**Conclusion:** Inadequate dental status is associated with high overall mortality. Our findings

suggest that systemic attention to dental status should be recommended in institutionalized elderly people.

**Key words:** dental status, mortality, activities of daily living, respiratory infections.

## Introduction

The loss of teeth is an irreversible process that peaks in old age and seriously influences oral function including mastication, deglutition and phonation.<sup>1</sup> A common cause of teeth loss in elderly people is alveolar pyorrhea, which can be prevented by intensive oral care.<sup>2</sup> Although elderly populations are retaining their teeth due to recent heightened concern about oral hygiene,<sup>3</sup> institutionalized elderly people still have poor oral health.<sup>4,5</sup> Simons reported that elderly people in residential homes had a high proportion of edentulousness of 57.4%, and high plaque and gingival indices of 2.3 and 1.7, respectively.<sup>6</sup> Moreover, in Japan, even though many institutionalized elderly people have lost many teeth, they do not use dentures to keep their masticatory capacity.<sup>7</sup> Such poor oral status of the institutionalized elderly may contribute to eating problems, low nutrient and an increase in intraoral bacteria.<sup>8-12</sup> Because many institutionalized elderly people are chronically infirm, these results may cause weight loss, disability and respiratory infections.<sup>13,14</sup>

Little is known about the effect of inadequate dental status for mastication on mortality in the institutionalized elderly. Shimazaki et al. demonstrated that institutionalized elderly people being edentulous without dentures were 1.8 times more prone to death during the 6-year follow-up as compared with those with 20 or more teeth.<sup>15</sup> However, they did not determine the underlying and immediate cause of death. Therefore, we conducted a study of elderly Japanese people to analyze recent dental status in nursing homes, poor dental status as a risk factor for mortality, and a relationship between dental status and specific causes of death. During the entire five-year follow-up period, these patients were examined. We also analyzed cognitive function and activities of daily living (ADL), which might be potentially

related to mortality.

## **Methods**

### ***Study population***

Subjects were members of the Oral Care Study cohort.<sup>16</sup> A total of 403 patients consisting of 86 men and 317 women, aged 65 years or older ( $82.8 \pm 7.7$  [mean  $\pm$  SD] years) were recruited at 9 nursing homes in Japan in September 1999. Each nursing home had 50-100 beds and served as long-term care facilities for older patients who were physically handicapped and/or suffering from mental deterioration.

The criterion for patient selection was that physical symptoms were stable for the preceding a month. All patients had no acute disorders, e.g., pulmonary diseases with dyspnea, infection, heart failure, or stroke requiring special treatment and intensive care. In addition, patients with immunocompromised disorders such as active malignant disease, renal dialysis, hypogammaglobulinemia or HIV-1 infection, were excluded from the study. Our study protocol was approved by the ethical review committee at Tohoku University School of Medicine, and all patients or their families provided written informed consent.

### ***Dental and clinical examination***

At baseline, we evaluated the patients' dental status for mastication. Patients were grouped into one of the following three categories according to different levels of dental status: Group A consisted of patients whose dental status was functionally adequate for mastication by natural teeth only or natural teeth with partial denture(s); Group B consisted of patients who were edentulous but kept their masticatory capacity by dentures in both jaws; Group C consisted of patients with a functionally inadequate dental status without dentures. There was



no significant difference in the percentage of the basic clinical conditions among the groups, of which information was given on admission by patients' family member and/or other reliable collateral source such as cardiac diseases, cerebrovascular diseases, hypercholesterolemia, diabetes mellitus and cardiac arrhythmias, and the use of medications for these diseases (Table 1). During follow-up, patients performed tooth brushing by themselves or by caregivers at least once a day. If patients were using dentures, nurses cleaned the dentures with a denture brush every day and with denture cleanser once a week.

Because of the potential effects on mortality, cognitive function and ADL were evaluated in all the patients. Cognitive function was examined using the Mini-Mental State Examination (MMSE).<sup>17</sup> ADL was evaluated using the modified Barthel Index.<sup>18</sup> Both MMSE and the modified Barthel Index have a 30-point scale for healthy older people, with a score of 0 indicating complete loss of cognition and dependence. If the MMSE score was 22 points or less, patients were considered as cognitively demented. If the modified Barthel Index was 20 points or less, patients were considered as physically disabled.

### *Following up the patients*

These patients were followed up for mortality until September 2004. If the patients were discharged from the nursing home, mortality was ascertained by contact with their families. When the patients died, the underlying and immediate causes of death were determined by medical doctors. Their death certificates and medical records were reviewed (by M.Y, T.M and T.O) and the only medical events leading directly to death were coded according to the ninth version of the International Classification of Diseases (ICD-9).<sup>19</sup> Any other records

about other significant conditions contributing to death, but not related to cause were not considered here.

### *Statistical analysis*

Statistical analyses were carried out with statistical software package SPSS version 10.0.

Baseline characteristics among age groups and different levels of dental status were compared by one-way ANOVA for continuous variables and by chi-square tests for categorical variables. When significant differences between groups were found, a post-hoc analysis was done to test by Fisher's test on the groups significantly differing from each other.

A Cox proportional-hazards model was used to estimate mortality risk by levels of dental status, with adjustments for other potential covariates: age, gender, basic clinical conditions, cognitive function and ADLs.<sup>20</sup> Because mortality, cognitive function and dental status are all strongly linked with age, all models were validated using graphical and analytical techniques to check for possible non-linearity and interactions. Kaplan-Meier curves were used to display the results. All tests were two-sided and statistical significance was set at  $P < 0.05$ .

## Results

### *Dental status and other variables*

Of the 403 patients who were evaluated at baseline, 192 (47.7%) were edentulous. The prevalence of edentulousness and number of natural teeth strongly correlated with age (Table 2). The prevalence of edentulousness for patients 65 to 74 years of age was 24.6%; this significantly increased to 40.4% for those 75 to 84 and to 63.4% for those 85 and older ( $P < 0.001$ ). The number of natural teeth for patients 65 to 74 years of age was  $9.4 \pm 8.9$ ; this significantly decreased to  $5.6 \pm 7.4$  for those 75 to 84 and to  $3.0 \pm 5.8$  for those 85 and older ( $P < 0.001$ ). Ninety-eight of the 192 edentulous patients (51.0%) were denture wearers and the prevalence significantly decreased in patients 85 and older ( $P = 0.008$ ).

When each patient was categorized into one of the groups according to levels of dental status, 99 patients met the criteria for Group A, which consisted of patients who had adequate dentition with natural teeth only or natural teeth with partial dentures, 98 patients were in Group B, which consisted of patients who were edentulous but wearing full dentures and 296 patients were in Group C, which consisted of patients who had inadequate dentition without dentures. In univariate analysis, these different levels of dental status were significantly associated with age ( $P < 0.001$ ), MMSE score ( $P < 0.001$ ) and Barthel Index ( $P < 0.001$ ) (Table 1).

### *Dental status and Overall Mortality*

During the first 2-year follow-up, 112 patients died. There were 14 (12.5%) deaths in Group A, 21 (18.8%) in Group B and 77 (68.8%) in Group C ( $P < 0.001$ ) (Table 1). By the end of the

5-year follow-up there were another 123 deaths, (total 235): 45 (19.1%) of the death were in Group A, 54 (23.0%) were in Group B, and 136 (57.9%) were in Group C ( $P = 0.002$ ) (Table 1) (Fig. 1).

In an unadjusted analysis, we examined the effect of dental status on 2-year and 5-year mortality. As compared with Group A, Group C had a relative risk of mortality of 3.09 (2-year: 95% CI 1.75-5.46,  $P < 0.001$ ) and 1.93 (5-year: 1.38-2.71,  $P < 0.001$ ); Group B did not significantly increase the risk of mortality (Table 3). After allowing for confounding effects of age, gender, basic clinical conditions including cardiac disease, cerebrovascular disease and diabetes mellitus, cognitive function and ADL, the 2-year risk of death among those in Group C was 1.84 times that of Group A (95% CI 1.01-3.36,  $P = 0.047$ ) (Table 3). However, the 5-year mortality among those of Group C was no longer significantly different from that of Group A (hazard ratio: 1.30, 95% CI 0.90-1.88,  $P = 0.168$ ). However, if age or ADL were excluded from the potential confounders, the dental status of Group C independently increased the 5-year mortality (data not shown).

### ***Dental Status and Specific Causes of Death***

The underlying and immediate causes of deaths are shown in Table 4. Respiratory infections (66 deaths) and senility (52 deaths) were common causes of 5-year mortality. The mortality rate by respiratory infections for patients in Group C was 18.4% (38 deaths/206 patients). This mortality rate was not significantly different as compared with that for patients in Group A (14.1%, 14 deaths/98 patients,  $P = 0.079$ ) and Group B (14.3%, 14 deaths/99 patients,  $P = 0.165$ ). Any other associations between a specific cause of death and the different dental status did not also reach a significant level (data not shown).

## Discussion

Our study had three major findings. First, inadequate dentition for mastication was common in institutionalized elderly patients over the age of 65, and its prevalence is clearly increasing with age and is strongly associated with impaired cognitive function and lower ADL. Second, this poor dental status was associated with approximately a two-fold increase in the 2-year risk of death independent of age, gender, basic clinical conditions, cognitive function and ADL. Third, this poor dental status was involved in overall mortality rather than mortality due to specific diseases such as respiratory infections because the number of events may have been too small to permit a detailed, cause-specific analysis.

It is well documented that many older patients in nursing homes have poor oral status. Other researchers have shown that such poor dental status was strongly associated with age, cognitive function and ADL.<sup>13,21</sup> Nordenram et al. reported significant correlations between the ability to chew and cognitive and functional capacity.<sup>22</sup> These findings may be explained in relation to the character of institutionalized elderly patients. For example, they are unlikely to perform personal oral hygiene care sufficient to keep adequate natural dentition because of impaired cognitive function and lower ADL.<sup>5,6</sup> With progression of the disease, demented patients would not keep their dentures on at ease and physically disabled patients may be recommended not to use dentures to prevent inspiration of the dentures.

Further, oral hygiene in long-term-care institutions has been neglected and there are different explanations for this, such as the difficulty of access to professional dental care,<sup>23</sup> little time to share by the staff,<sup>24</sup> and lack of understanding, knowledge, interest by the staff including primary care physicians and geriatricians.<sup>25,26</sup> On the basis of such conditions for

oral health and care, many institutionalized elderly may lose their teeth and may be unsatisfactorily treated.

We found that inadequate dentition for mastication significantly increased the risk of 2-year overall mortality in institutionalized elderly patients. A few reports have shown that edentulous people without dentures are significantly prone to death as compared to those with adequate dentition in community dwelling elderly people<sup>27,28</sup> or institutionalized elderly people.<sup>15</sup> Appollonio et al. reported that edentulous people without dentures had a significant risk for death independent of physical-mental health status at baseline and discussed that poor dental status may have negative effects on mortality through malnutrition.<sup>28</sup> In another report they showed that inadequate dental status and micronutrients such as folate were significant and independent predictors of mortality in community-dwelling elderly women.<sup>29</sup> Moreover, a number of studies have shown that poor dental status is associated with malnutrition.<sup>30,31</sup> Although we did not consider estimating nutritional status such as body weight, serum albumin, previous studies strongly suggest that inadequate dental status and the susceptibility to death are partly linked by malnutrition.

In contrast, the present study showed that inadequate dental status did not seem to be an independent prognostic variable of 5-year mortality but an associated variable of other strong predictors of mortality, such as increasing age and low ADL. Adjustment for these factors weakened the predictive power of dental status. A possibility is that longer survival rates may be greatly influenced by age and ADL because these older and frail patients might reach the end points sooner apart from dental status.

In our study, death from respiratory infections was scored as a primary cause of death, and

no other terminal diseases entered into this group.<sup>32</sup> Therefore, the prevalence of the death from respiratory infections might have been underestimated because people diagnosed as senility were in poorly defined conditions and likely to have underlying disease conditions such as asymptomatic pneumonia.<sup>32</sup> Although a direct and independent relationship between poor dental state and death from respiratory infections remains unclear, it is recognized that respiratory infections can be the result of infection by anaerobic bacteria, and dental plaque would seem to be a logical source of these bacteria, especially in patients with periodontal disease.<sup>12</sup> Poor dental health may contribute to the development of pneumonia as an independent or associated prognostic variable.<sup>33</sup> We previously demonstrated that intensive oral care lowered the frequency of pneumonia by 50% in the institutionalized elderly.<sup>14</sup> Therefore, intensive oral care should be recommended for patients who cannot keep their teeth clean by themselves to prevent respiratory infections.<sup>34</sup>

A potential weakness of the study is that patients' concurrent illness that would have affected their prognosis was not fully confirmed and nor followed-up because of limited capacity for objective evaluation in the nursing homes and unwillingness for intensive medical care for relatively old patients. Further, lack of patients' subjective compliant due to limited ADL and cognitive function, especially in Group C might have made it difficult to identify an underlying fatal disease (Table 4). These provide possible reasons why senility was negatively selected as a cause of death without the supportive evidence.

Another limitation of the present study was that the baseline examination of dental status might not reflect their lifetime dental status, and thus not effectively stratify their risk. This might be true especially for elderly people with comorbidity, causing increased mortality and

inadequate dental status when close to death. This factor may explain, hypothetically, the association between inadequate dental status and mortality in institutionalized elderly.

Although 30 edentulous patients who had dentures but had not used them were included in Group C, their mortality rates were similar to that of the other edentulous patients who did not have dentures (data not shown); therefore, such a distorting mechanism is thus unlikely.

In summary, our findings highlight a broader concern about inadequate dental status for mastication in institutionalized elderly people and its relation to poor outcomes. Moreover, the present study provides a basis for keeping an adequate dental status in institutionalized elderly patients in order to minimize poor dental status related deaths. Thus, our findings suggest that systemic attention to dental status should be recommended. However, further study about the relationship between poor dental status and specific causes of mortality is necessary to better elucidate the role of poor dental status both as a precursor and as a sequel of disease states to improve methods for its management.



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