Relationship between Occlusal Conditions and Dietary Habits among Students of the Niigata Prefectural College for the Elderly

Takahiro Tazawa¹, Atsuko Igarashi¹, Reiko Watanabe² and Shuichi Nomura³

Abstract: The majority of studies showing the relationship between occlusal conditions and health conditions of the elderly have been conducted either on residents in nursing homes or on patients in hospitals for the elderly. Thus, there is a lack of data on the independent elderly, who form the majority of seniors. In this study, an actual condition survey of students of a college for the elderly was carried out. The object was to establish the relationship between their occlusal conditions, chewing ability and their dietary habits. The study produced concrete basic data on the healthy middle and elderly persons in order to clarify the significance of chewing function maintenance in the elderly.

The subjects of the study were 101 students (63 males and 38 females, mean age: 66.0 ± 4.9 years) of Niigata Prefectural College for the Elderly, who took part in a questionnaire survey of their dietary habits. They consented to participate in the survey of their occlusal condition, chewing ability and nutritional intake condition.

Of these subjects, 36 wore dentures; and 65 did not. According to the Eichner's classification, the majority of the subjects kept four occlusal supporting areas. The mean number of existing teeth per person was 22.8 ± 7.7 and the mean and standard deviation of the maximum occlusal force were 661.5 ± 362.7 N. When the subjects were classified into three groups by the chewing ability, the lower chewing ability group showed an increased intake ratio of sodium chloride compared to that of the higher chewing ability group. Based on the above-described results, it was concluded that favorable occlusal conditions were maintained among students of the college for the elderly as compared with the average elderly of the same generation. At the same time, it was suggested that chewing ability may relate to the intake of nutrients of healthy middle-aged and elderly persons.

Key words: occlusal condition, chewing ability, dietary habits, nutritional intakes, college for the elderly

Introduction

In all generations, good oral condition is an important factor in chewing ability, taste perception, phonetics and aesthetics. Since the dietary intake is greatly influenced by the oral functions such as chewing and swallowing, it is an important role of the dental services in the upcoming ultra-aged society to secure the qualitative and quantitative satisfaction of the elderly in eating. Since aggravation of oral condition of the elderly restricts eatable foods, decreases the pleasure of eating foods and induces low nutrition, the maintenance of chewing ability is a very important factor in QOL. The majority of studies on occlusal conditions and dietary habits of the elderly in

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Japan and overseas have been conducted either on residents in nursing homes or on patients in hospitals. Thus, there is a lack of data on the independent elderly who have no difficulties in everyday life, who form the majority of seniors.

In this study, an actual condition survey of students of a college for the elderly was carried out. The objective was to establish the relationship between their occlusal conditions, chewing ability and their dietary habits. The study produced concrete basic data on the healthy middle and elderly persons in order to clarify the significance of chewing function maintenance in the elderly.

**Materials and Methods**

1. **Subjects**

The subjects of this study were 101 persons (63 males and 38 females, mean age: 66.0 ± 4.9 years, males: 67.3 ± 5.1 years, females: 63.8 ± 3.8 years) out of 428 students of Niigata Prefecture College for the Elderly in 2000 and 2001 who agreed to take part in the interview and survey in Niigata University Dental Hospital. Fig. 1 shows the gender and age distribution of the subjects. The subjects were characterized by a large number of elderly in their sixties and a markedly higher percentage of males aged 70 years or more. The Foundation of Niigata Prefecture Longevity Promotion sponsored the lectures in the Niigata Prefectural College for the Elderly, targeting the elderly (aged about 60 years or more) living in Niigata Prefecture.

2. **Survey**

A survey of the following items was performed after asking the subjects about past history of systemic diseases and drugs habitually used.

1) **Occlusal conditions**

Missing teeth, dental restorations, dental caries, and periodontal disease were examined. Occlusal conditions were evaluated by examining occlusal contacts in intercuspation and the maximum occlusal force. The occlusal contacts in intercuspation were identified with an articulating paper, and occlusal support of the posterior teeth was evaluated according to Eichner’s classification of partial edentulous arches. Occlusal force and contact area when the maximum occlusal force was applied for 3 seconds were recorded using the pressure sensitive sheet Dental Prescale® 50H R type (GC corporation) and analyzed with Occluzer® FPD703 (Fuji Photo Film Co.).

2) **Chewing ability**

Chewing ability was objectively evaluated by measuring chewing efficiency using about 4.3 gram experimental gummi-jelly. After 10 times chewing, the concentration of glucose eluted from the gummi-jelly was measured with an average was calculated.
3) Dietary intake
(1) A simple food intake questionnaire
A simple food intake questionnaire was conducted to evaluate nutritional intake using the Convenient Dietary Survey Method, developed by Morimoto et al. In addition to three meals a day, snacks, drinks, and alcohol are included in the questions. The subjects themselves filled in the questionnaire form under the guidance of the dentist.

(2) Questionnaire on daily living activities
"Physical activity questionnaire table" (self-administered questionnaire), prepared by the authors with reference to the items of "questionnaire survey" on life conditions and daily physical activity conditions used in the Niigata City Elderly Cohort Survey was sent by mail to the subjects to be filled out. The details of the activity were investigated on each subject on the basis of "the standard of intensity of daily activity" of the Recommended Dietary Allowances for Japanese? Dietary Reference Intake 6th ed. to obtain the activity factor of daily living.

(3) Nutritional assessment
Requirements of energy and macronutrients in each subject were calculated to evaluate nutrient intakes and the ratios of the intakes to nutritional requirements were calculated. The energy requirement was calculated from the body weight and physical activity factor in each subject using the basal metabolism standard values (males aged 50 years or more: 21.5 kcal/kg/day and females aged 50 years or more: 20.7 kcal/kg/day) based on stratified sex and age.

Recommended protein allowances in males and females were calculated by multiplying the body weight by 1.01 g/kg/day for subjects aged 69 years or less and 1.13 g/kg/day for those aged 70 years or more. The fat energy percentage of total energy was set at 22.5% because the recommended values were 20-25%. In addition, the carbohydrate energy ratio was set at 60% of the energy requirement. Since the recommended sodium chloride allowance was 10 g/day or less, the ratio was calculated by comparing the actual intake with the recommended sodium chloride allowance.

Since the present study was conducted to clarify the relationship between occlusal condition and dietary habits, the examination and classification were made under the condition of wearing the dentures at the time of meals. In other words, the examination and classification were adjusted to the occlusal conditions at meals.

3. Statistical analysis
All the data were expressed as mean ± S.D.. Unpaired t test was used for the analysis of groups classified by sex or denture wearing condition. Also, the body mass index (BMI), activity factor, ratio of energy requirement, ratio of protein satisfaction, ratio of fat energy satisfaction, ratio of carbohydrate energy satisfaction and ratio of intake of sodium chloride between groups classified by chewing ability were analyzed by one-way ANOVA test. The ANOVA test was applied followed by a Tukey correction for multiple comparisons. The statistically significant differences were judged at a 5% level of significance.

Results
1. Occlusal conditions
The mean number of existing teeth per person was 22.8 ± 7.7 (male: 22.6 ± 7.7 and female: 23.0 ± 7.7). The situation of denture use is shown in Fig. 2; the number of persons wearing dentures was 36 and the total number of persons wearing complete dentures, at least in one jaw, was 11. On the other hand, 65 persons did not use dentures. Thirty-six persons among them had a complete dentition with their natural teeth or fixed restorations, and other persons had a small number of missing teeth that had not been replaced.

The occlusal condition of posterior teeth according to Eichner's classification is shown in Table 1. Seventy-seven persons, three quarters of the sub
Occlusal Conditions and Dietary Habits (Tazawa et al.)

Figure 2 Type of denture used
C-P means upper complete denture and lower partial denture wearer, and P-C means upper partial denture and lower complete denture wearer.

Table 1 Number of subjects according to Eichner’s occlusal classification

<table>
<thead>
<tr>
<th>Class</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>20</td>
<td>3</td>
<td>16</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>101</td>
</tr>
</tbody>
</table>

Class A: There are 4 occlusal support areas, that is, 2 areas in the premolar region bilaterally and 2 in the molar region bilaterally.
A1: No missing tooth, A2: Missing teeth unilaterally, A3: Missing teeth bilaterally

Class B: At least one occlusal support area is lost.
B1: There are 3 occlusal support areas, B2: 2 occlusal support areas, B3: one occlusal support area, B4: occlusal contacts at anterior teeth without occlusal support area.

Class C: There is no occlusal support area.

The mean maximum occlusal force was 661.5 ± 362.7 N (male: 674.7 ± 363.1 N, female: 639.6 ± 365.7 N).

2. Chewing ability

The mean concentration of eluted glucose was 285.4 ± 102.5 mg/dl (male: 287.5 ± 99.5 mg/dl and female: 282.0 ± 108.6 mg/dl) as shown in Fig. 3.
The subjects were classified into 3 groups by the chewing ability: the middle chewing ability group, with a chewing ability within the range of mean ± 1/2 S.D., the higher chewing ability group, with a chewing ability higher than the middle group, and the lower chewing ability group, with a chewing ability lower than the middle group.
3. Dietary intake

The mean values of BMI were 22.7 ± 2.2 in males and 22.5 ± 2.8 in females, and those of activity factors were 1.52 ± 0.20 (Table 2). When the data were compared between the sexes, the physical activity factor was higher in females than in males, with significant differences (p<0.05). When the data were compared between denture wearers and non-denture wearers, there was no significant difference between the two groups.

The dietary intake of energy and nutrients compared with the mean intake in persons aged 60-69 years as found in the national nutrition survey by MHLW in 2000 are shown in Table 3. The ratio of intake to energy requirement, to protein allowance, to fat energy, to carbohydrates energy and to sodium chloride allowance per day per subject are shown in Table 4. As a whole, the ratio of intake to protein allowance, to fat energy and to sodium chloride allowance were all higher than 100%. There were significant differences between males and females in the ratio of intake to protein allowance and to fat energy (p<0.01). In addition, when the data were compared between denture wearers and non-denture wearers, there was no significant difference between the two groups.

Table 2 Physical activity factor

<table>
<thead>
<tr>
<th></th>
<th>All Subjects (n=101)</th>
<th>Male (n=63)</th>
<th>Female (n=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity factor</td>
<td>1.52 ± 0.20</td>
<td>1.49 ± 0.20</td>
<td>1.59 ± 0.19</td>
</tr>
</tbody>
</table>

*p<0.01 Unpaired t test

Table 3 Dietary intakes of energy and nutrients

<table>
<thead>
<tr>
<th></th>
<th>All Subjects (n=101)</th>
<th>National Nutrition Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (Kcal)</td>
<td>1,644 ± 280</td>
<td>1,978 ± 574</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>64.3 ± 10.5</td>
<td>81.3 ± 27.6</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>44.6 ± 9.8</td>
<td>51.3 ± 21.9</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>227 ± 55</td>
<td>280 ± 83</td>
</tr>
<tr>
<td>Sodium chloride (g)</td>
<td>136 ± 3.1</td>
<td>136 ± 5.6</td>
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</tbody>
</table>

Table 4 Satisfactory condition of nutrients

<table>
<thead>
<tr>
<th>The ratio of intake to</th>
<th>All Subjects (n=101)</th>
<th>Male (n=63)</th>
<th>Female (n=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy requirement (%)</td>
<td>94 ± 20</td>
<td>95 ± 22</td>
<td>93 ± 19</td>
</tr>
<tr>
<td>protein allowance (%)</td>
<td>113 ± 23</td>
<td>107 ± 20</td>
<td>124 ± 25</td>
</tr>
<tr>
<td>fat energy (%)</td>
<td>103 ± 32</td>
<td>96 ± 28</td>
<td>115 ± 35</td>
</tr>
<tr>
<td>carbohydrate energy (%)</td>
<td>86 ± 22</td>
<td>86 ± 23</td>
<td>87 ± 20</td>
</tr>
<tr>
<td>sodium chloride allowance (%)</td>
<td>136 ± 31</td>
<td>136 ± 1</td>
<td>137 ± 32</td>
</tr>
</tbody>
</table>

**p<0.01 Unpaired t test
As shown in Table 5, the lower chewing ability group showed an increased sodium chloride intake than the higher chewing ability group. The higher chewing ability group showed less carbohydrate energy intake than the middle chewing ability group.

On the other hand, there were no significant differences among the 3 groups in BMI and physical activity factor (Table 6).

### Discussion

1. Occlusal condition and chewing condition

   The mean number of existing teeth per subject was $22.8 \pm 7.7$, a value larger than 17.1, which is the number of existing teeth per person in the same generation described in the report on the survey of dental diseases in 1999. The mean maximum occlusal force value was $661.5 \pm 362.7$ N (male: $674.7 \pm 363.1$ N, and female: $639.6 \pm 365.7$ N). In a study of Miura et al. using the same Dental Prescale, the mean maximum occlusal force values were 408 N for males and 243 N for females, in healthy persons aged 65-74 years. In our study, there were 47 persons under 65 (46.5% of the subjects) and more than three quarters of the subjects belonged to Class A of the Eichner’s classification. Accordingly the large power of muscle contraction and stable occlusal supports would produce higher value of the maximum occlusal force.

   Gummi-jelly was used to measure chewing efficiency. With the progress of chewing, the gummi-jelly was increasingly fragmented and its surface area increased, eluting greater amounts of glucose from the fragment surfaces. This method is reported to be the effective function evaluation method for persons with low chewing efficiency. The weight of our experimental gummi-jelly used was about 4.3 g and the frequency of chewing was set at 10 times, but since the weight of gummi-
jelly, frequency of chewing and/or time of chewing are different among other studies, direct comparison of the eluted glucose could not be made.

2. Dietary intakes

The mean physical activity factors were 1.49 ± 0.20 in males and 1.59 ± 0.19 in females. From the level of the physical activity factor, the subjects were estimated to live mainly in a sitting posture and their daily activity was estimated to be static.

According to the report by Watanabe et al., the mean physical activity factors of the healthy free-living elderly aged 74 years were 1.44 ± 0.29 in males and 1.38 ± 0.12 in females. The mean physical activity factors in our study were considered to be appropriate considering that the subjects were 10 years younger than the persons in the report. When compared by sex, the mean physical activity factor of females was higher than that of males, on the ground that the average age of females was younger than that of males and the percentage of females doing cooking, washing, cleaning and shopping was considered to be higher than that of males.

The mean values of BMI were 22.7 ± 2.2 in males and 22.5 ± 2.8 in females in our study and were similar to 22.5 ± 1.6 in males and 21.8 ± 1.9 in females, that were ideal BMI values shown in the results of the National Nutrition Survey of 1998. Nutrition intake and metabolism were considered to be balanced among the subjects in our study.

When the intake of nutrients in the subjects was compared with the mean intake in persons aged 60-69 years (age stratification) in the results of the national nutrition survey by MHLW in 2000, the former was lower than the latter on the whole. Watanabe et al. pointed out that the “Convenient Dietary Survey Method” had the disadvantage that it underestimated or overestimated the amount of food that participants had eaten. In the survey by Watanabe et al., after the subjects filled the questionnaire form, a dietitian confirmed the intake values while checking food samples. However, such a process was not performed in our study. Therefore, the estimated intake values could have been lower on the whole compared with the actual intake values.

There were significant differences between males and females in the ratio of intake to protein allowance and ratio of intake to fat energy. The national nutrition survey by MHLW in 2000 reported that the frequency of preparing meals was higher in females than males, and females had higher interest in nutrition and meals. In addition, the younger average age of females and the higher percentage of alcoholic drinkers of males may explain the differences in the ratio of intakes between them.

When the 3 groups as divided by the chewing ability were compared with each other, the intake of sodium chloride in the lower chewing ability group was significantly higher than that in the higher chewing group. The decrease in chewing ability is considered to promote the change in meals to intake of processed food that is easy to eat. Unfortunately, processed food contains much salt. The excessive intake of salt is known as a risk factor causing hypertension, cerebral apoplexy and stomach cancer. From the viewpoint of aging, one report states that the progress of aging becomes rapid in persons taking much salt. It is interesting to note that the ratios of intake showed the largest value in the middle chewing ability group except for the sodium chloride allowance. The ratio of intake of carbohydrate in the middle chewing ability group was significantly higher than that in the higher chewing group. Further studies should be performed to elucidate the reason for these results.

Consequently, it can be said that the chewing ability relates to the intake of nutrients, especially the intake of salt, and is considered to be important for the systemic health conditions among students of the college for the elderly.
Conclusion

This study was conducted to elucidate the relation between the occlusal conditions and chewing ability of the students of the college for the elderly and their dietary habits. The results of this study showed that favorable occlusal conditions were maintained as compared with the average elderly of the same generation. At the same time, it was suggested that chewing ability may relate to the intake of nutrients of healthy middle-aged and elderly persons.

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References

新潟県高齢者大学受講生における咬合状態と食生活との関係

田澤 貴弘1）、五十嵐敦子1）、渡邊 令子2）、野村 修一3）

抄録：高齢者の口腔と健康状態に関する報告では、介護施設入所者や医療機関受診者を対象としたものが多く、高齢者の中で多数を占める自立した高齢者に関するデータは十分でない。そこで本研究では、高齢者が咀嚼機能を保持する重要性を明らかにするために、高齢者大学受講生の咬合状態、咀嚼能力と食習慣との関係を調査して、健康な中高年における具体的な基礎資料を得た。

新潟県高齢者大学の受講生を対象とし、食生活に関するアンケート調査に参加し、新潟大学歯学部附属病院での面接調査に同意した101名（男性63名、女性38名、平均年齢66.0歳）を対象とし、咬合状態、咀嚼能力、栄養摂取状況について調べた。

義歯装着者は36名で、片義のものを含めた総義歯装着者は11名であった。一方、義歯を使用していない人は65名であった。アイヒナーの咬合分類では、4ヶ所の咬合支持域が保たれている人数を占めた。一人平均現在歯数は22.8本、最大咬合力の平均値と標準偏差は661±363 Nであった。被験者の咀嚼能力で3群に分けた時、咀嚼能力が低い群は高い群に比べて食塩摂取比率が高かった。以上の結果から、高齢者大学受講生は同世代の平均的な人達よりも良好な咬合状態を保持していた。また、咀嚼能力は中高年者の栄養摂取に関連していることが示唆された。

キーワード：咬合状態、食生活、咀嚼能力、栄養摂取、高齢者大学

1）新潟大学大学院歯学総合研究科歯食・歯下障害学分野
2）新潟女子短期大学生活科学学科食物栄養専攻
3）新潟大学大学院歯学総合研究科加齢・高齢者歯科学分野