Original article

Masticatory performance of the elderly as seen from differences in occlusal support of residual teeth

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A B S T R A C T

Purpose: To clarify whether the occlusal state affects the masticatory performance of elderly adults.
Methods: Elderly women were asked to chew a gummy jelly, and the amount of glucose extraction was measured as the parameter for masticatory performance. Subjects were divided into five groups depending on occlusal support on the habitual chewing side (G1: no occlusal support of posterior teeth, G2: occlusal support of first premolar, G3: occlusal support of premolars, G4: occlusal support from first premolar to first molar, and G5: occlusal support from first premolar to second molar). It was also investigated whether or not the subjects were wearing dentures. The amount of glucose extraction was compared among the five groups and then between subjects with removable denture and subjects without removable denture. The relationship between age and glucose extraction were also investigated.
Results: The amount of glucose extraction progressively increased with increase in number of occlusal support. There were no fixed tendencies between age and glucose extraction, when occlusal state was taken into account. The amount of glucose extraction of subjects without removable denture was significantly larger than that of subjects with removable denture. It was also found that 67 % of subjects with removable denture were within the normal range when it was set based on G5 data.
Conclusions: It was suggested that the occlusal state affected the masticatory performance of elderly adults.

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1. Introduction

Masticatory performance is considered to be an important parameter for objectively evaluating masticatory function. One standard method of evaluating masticatory performance is sieving method, in which the subject chews a test food for a specific number of times, and the crushed test food is collected from the oral cavity and divided by sieving according to particle size [1]. However, disadvantages of this method are the fact that it is complicated to perform and analysis is time-consuming.

Recently, simple methods using silicone impression materials, chewing gum, paraffin wax, and gummy jelly have been introduced [2–13]. Of these, the measurement of glucose extraction during the chewing of gummy jelly has garnered attention for its utility due to gummy jelly as a test food having standardized properties, shape, simple hygiene management, and straightforward operations and analysis. It has been reported that there is a significant positive correlation between masticatory performance measured with this method and that measured with sieving method [4].

Because humans have a habitual chewing side and functional differences have been found between the habitual and non-habitual chewing sides, as well as between free and unilateral chewing [14], many studies have come to use unilateral chewing on the habitual chewing side for the evaluation of masticatory movement [12,13,15]. Therefore, some studies are performed using unilateral chewing on the habitual chewing side to evaluate masticatory performance [5,8–10,15–17].

It has also been reported that masticatory performance is affected by occlusal state such as the number of molars or occlusal support region [7,18]. Therefore, in order to measure masticatory performance on the habitual chewing side and study masticatory performance by occlusal state in elderly adults, occlusal state in the habitual chewing side needs to be investigated. However, no previous studies have evaluated masticatory performance by occlusal state on the habitual chewing side. Moreover, it has been reported that there are gender-related differences in masticatory performance [9].

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Therefore, in order to clarify whether the occlusal state affects the masticatory performance of elderly adults, considering gender-related differences, investigated occlusal state on the habitual chewing side and analyzed glucose extraction during gummy jelly chewing in elderly women. The hypothesis was that masticatory performance in elderly adults is influenced by occlusal state (i.e., number of occlusal support and presence or absence of wearing removable denture).

2. Material and methods

2.1. Ethics statement

This study was carried out with the approval of the Ethics Committee of Nippon Dental University School of Life Dentistry (NDU-T2012-29). Informed consent was obtained from all subjects after they were received the general nature of the study.

2.2. Subjects

The subjects comprised 149 elderly women (age range, 65–89 years; average age, 72.3 years) who participated in the Kita-ku Enjoy Dietary Education Together Fair held in Kita-ku, Tokyo. They were independently living elderly women over the age 65 years. Subjects with a bridge or implant on the molar region of their habitual chewing side were excluded.

2.3. Test food

The test food was a cylindrically shaped gummy jelly (GC, Tokyo, Japan) with a diameter of 14 mm, height of 10 mm, and weight of about 2 g.

2.4. Recording method

2.4.1. Masticatory performance

The researcher asked the subjects which side was preferred to chew food. Subjects were asked to chew a gummy jelly for 20 s on their habitual chewing side. After chewing, the subjects were asked to hold 10 ml of distilled water in their mouth for a moment and to spit into a cup with a filter. The glucose concentration in the filtrate was measured using a glucose measuring device (GS-2; GC, Tokyo, Japan). The amount of glucose extraction was used as the parameter of masticatory performance. Subjects wearing removable denture were asked to chew a gummy jelly with the denture.

2.4.2. Occlusal support

Subjects were divided into five groups depending on occlusal support which consists of occlusal contacts of existing natural teeth (G1–G5, G1: no occlusal support of the posterior teeth, G2: occlusal support of the first premolar, G3: occlusal support of the first and second premolars, G4: occlusal support from the first premolar to the first molar, and G5: occlusal support from the first premolar to the second molar). It was also investigated whether or not the subjects were wearing dentures.

2.5. Analyzing method

The SPSS for Windows 15.0J, Chicago, IL, USA, was used for data analyses. First, the amount of glucose extraction was compared among the five groups (G1–G5) depending on occlusal support on the habitual chewing side. The significance of differences among the groups was evaluated by analysis of variance (ANOVA). When significant effects were identified, Bonferroni's correction was used. It was followed by comparison between subjects with removable denture and subjects without removable denture (full natural dentition) using an independent t-test. The Kolmogorov–Smirnov test was used to test for normality. The Levene test was used to test for equality of variance. After investigating the relationship between age and glucose extraction in all subjects, possible correlations between age and glucose extraction in each group were investigated. The presence or absence of a statistically significant correlation between age and glucose extraction was determined by calculating the Pearson's correlation coefficient. All statistical analyses were performed with significance level set at p values of 0.05.

3. Results

The number of subjects and age of each group were the following: G1 (n = 29; age range, 65–89 years; average age, 76.9 years), G2 (n = 21; age range, 65–85 years; average age, 71.6 years), G3 (n = 24; age range, 65-88 years; average age, 72.4 years), G4 (n = 28; age range, 65–79 years; average age, 70.4 years), G5 (n = 47; age range, 65–82 years; average age, 70.9 years) (Table 1). The number of occlusal support on the non-habitual chewing side decreased compared with that on the habitual chewing side (G1, n = 49; G2, n = 24; G3, n = 42; G4, n = 22; G5, n = 12) (Table 1).

The amount of glucose extraction tended to progressively increase with increasing number of occlusal support, and there were significant differences between G1 and G4, G1 and G5, G2 and G5, G3 and G5, and G4 and G5 (Tables 2 and 3). The amount of glucose extraction of subjects without removable denture (210.0 mg/dL) was significantly larger than that of subjects with removable denture (162.1 mg/dL). It was also found that 59 % of G1 (17 of 29 subjects), 67 % of G2 (14 of 21 subjects), 75 % of G3 (18 of 24 subjects), 86 % of G4 (24 of 28 subjects) were within the normal range when it was set based on G5 data (within mean $\pm 2 \times$ standard deviation). In addition, it was also found that 67 % of subjects with removable denture (49 of 73 subjects) was within the normal range.

Although a negative correlation was noted between age and glucose extraction in all subjects, when this relationship was examined by occlusal support, there were no fixed tendencies between age and glucose extraction in any of the groups and no correlation was found (Table 4).

4. Discussion

Assessment of occlusal support is commonly performed using the number of functional teeth [11,18–21] and the Eichner Index [6,7,11,22–26]. Because assessments based on the number of functional teeth include teeth that have been repaired through the use of bridges, implants, and removable dentures, the presence or absence of such repairs can be expected to influence masticatory performance.

Bilateral assessment is performed when using the Eichner Index; therefore, even if all teeth are present on the habitual

Table 1
The number of subjects of the 5 groups

Group	Habitual chewing side					
	G1	G2	G3	G4	G5	G1–G5
Non-habitual chewing side						
G1	19	11	9	6	4	49
G2	4	6	6	3	5	24
G3	6	4	7	10	15	42
G4	0	0	2	7	13	22
G5	0	0	0	2	10	12
G1–G5	29	21	24	28	47	149