Evaluation of occlusal force and masticatory performance in elderly adults with natural dentition unaffected by occlusal support

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Abstract

Purpose: This study aimed to clarify whether occlusal force and masticatory performance reduced in elderly adults and whether these parameters were affected by age.

Methods: Seventy-eight elderly adults (elderly group) and 76 young adults (control group) with natural dentition were asked to maximally clench for 3 s, and occlusal force was calculated. The amount of glucose extraction after chewing a gummy jelly was measured as the parameter for masticatory performance. Occlusal force and masticatory performance were compared between the elderly and control groups. The correlation between age and occlusal force and between age and masticatory performance was also investigated.

Results: Occlusal force was significantly smaller in the elderly group (P < 0.05). Masticatory performance was lower in the elderly group, but this difference was not statistically significant. No significant correlation was observed between age and occlusal force in the control group, but a negative correlation was found in the elderly group (P < 0.05). No significant correlation was found between age and masticatory performance in either group.

Conclusion: Occlusal force was affected by age and reduced significantly, whereas masticatory performance was not affected by age and was maintained in elderly adults.

Materials and Methods

Subjects

Seventy-eight elderly adults (elderly group: 35 males and 43 females, average age 75.8 years old) aged 65 years or older and 76 young adults (control group: 34 males and 42 females; 21 to 49 years old; average 34.4 years old) participated in this study. The selection criteria were: 1) no clinical abnormalities in the masticatory system, 2) natural dentition, with the possible exception of the third molars, and 3) no complaints regarding occlusion.

Experimental design

Subjects were asked to chew a gummy jelly freely and pick the side on which chewing was easier. Subjects were then asked to clench their jaw maximally for approximately 3 seconds, and occlusal force on their habitual chewing side was calculated as a parameter for occlusal force. Next, the amount of glucose extraction after chewing a gummy jelly on the habitual chewing side for 20 s was measured as a parameter for masticatory performance. The occlusal force and masticatory performance were recorded once.

Occlusal force

A prescale of appropriate size (Dental Prescale II, GC Inc., Tokyo, Japan) was inserted into the oral cavity such that the entire dentition would fit on the film. Subjects were asked to clench their jaw maximally in the intercuspal position for about 3 seconds, and were instructed to exert maximum strength that could be sustained according to the method reported by Shiga et al. [22]. Then, the occlusal force on the habitual chewing side after cleaning was calculated using an occlusal force analyzing system (GC Inc.).

Masticatory performance

Subjects were asked to chew a gummy jelly (Glucolumn, GC Inc.) on their habitual chewing side for 20 seconds, and then hold 10 mL of water in their mouth and spit into a cup with a filter. The filtrate in the cup was collected as a test sample, and the glucose concentration was measured using a glucose measuring device (GS-II, GC Inc.). The measured value was used as the amount of glucose extraction.
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Discussion

and masticatory performance in the control and elderly groups (Table 4).

was a negative correlation in the elderly group (males:
was found between age and occlusal force in the control group, but there
ferences were observed between them (Table 2). No significant correlation
was found between age and occlusal force in the control group, but there
was a negative correlation in the elderly group (males: P = 0.016, females:
P = 0.002) (Table 3). No significant correlation was found between age
and masticatory performance in the control and elderly groups (Table 4).

Statistical analysis

All data were analyzed using Statistical Package for the Social Sciences for
Windows 15.0 J (SPSS, Chicago, IL, USA). Occlusal force and amount of
glucose extraction on the habitual chewing side were compared between the
elderly and control groups. The correlation between age and occlusal force
and between age and masticatory performance were investigated in both groups. After confirming normality by the Shapiro-Wilk test, an
independent t-test was used to compare values between the two groups, and Pearson’s correlation coefficient was used to evaluate the correlation
between age and both occlusal force and masticatory performance. A
P-value < 0.05 was considered significant in all analyses.

Results

Occlusal force was smaller in the elderly than in the control group, with
statistically significant differences between the elderly and control groups
(males: P = 0.024, females: P = 0.009) (Table 1). Masticatory performance
was lower in the elderly than in the control group, but no significant dif
ferences were observed between them (Table 2). No significant correlation
was found between age and occlusal force in the control group, but there
was a negative correlation in the elderly group (males: P = 0.016, females:
P = 0.002) (Table 3). No significant correlation was found between age
and masticatory performance in the control and elderly groups (Table 4).

Discussion

Similar to a dominant hand, humans have a habitual chewing side on
which chewing is easier and show a functional difference compared with
the non-habitual side [4,23]. Recently, the habitual chewing side has come
to be used when evaluating masticatory performance [9,10,17]. There
fore, in this study, the habitual chewing side was selected as the side for
evaluating masticatory function (occlusal force and masticatory perfor
mance). Although not analyzed in this study, many parameters, such as
grasp strength, oral quality of life, masticatory score, and nutritional status
were recorded. Therefore, though it is desirable to consider the average of
multiple records to evaluate occlusal force and masticatory performance,
only one record was used.

A number of researchers investigated factors related to masticatory
function (occlusal force and masticatory performance), and reported that
masticatory function is more affected by occlusal support and gender
than by age [2,3,15]. However, these studies also included subjects with
insufficient or missing occlusal support. Therefore, in order to clarify the
relationship between masticatory function and age, it is necessary to elimi
nate the influence of occlusal support and gender. Therefore, in this study,
subjects with a complete natural dentition were selected to eliminate the
effects of occlusal support. Moreover, to eliminate the influence of gender,
the analysis was performed by distinguishing between males and females.

Chong et al. [11] investigated occlusal force in young and elderly adults with ≥20 teeth and found no significant difference between the two
groups. However, according to their results, young adults presented larger
occlusal force as compared to elderly adults. They also found that occlusal
force in elderly adults varied widely (185 to 1,200 N). Since all subjects
had ≥20 teeth, some may have had insufficient occlusal support (small
occlusal force), which could be the cause of the large variation in force.
This presumably affected the results, and there was no significant differ
ence between the two groups. Based on these findings, it is impossible
to conclude that there is no relationship between occlusal force and age.
Therefore, it is necessary to examine participants with complete natural
dentition, as done in this study. This study investigated the occlusal force
in elderly and young adults with complete natural dentition and found that
it was significantly smaller in the elderly than in young adults. Regarding
the relationship between age and occlusal force, no significant correlation
was found in young adults, but a negative correlation was found in the
elderly group. From the results of this study and the reports that physical
strength and muscle strength decrease with age, it can be concluded that
the occlusal force in elderly adults, even in those with complete natural
dentition, decreases with age.

Kosaka et al. [15] classified elderly adults into three groups (Eichner A
to C) and investigated factors related to masticatory performance in each
group. They reported that masticatory performance was significantly asso
ciated with occlusal force in all groups. Based on this result and the fact
that occlusal force in elderly adults is significantly reduced, it is expected
that masticatory performance may also reduce significantly. Tanaka et al.
[17] classified elderly adults into five groups with occlusal support of the
molars and investigated masticatory performance in each group. They
reported that masticatory performance was significantly reduced even with
the loss of a single second molar. To evaluate masticatory performance
in elderly adults thoroughly, those with complete natural dentition need
be studied. Therefore, this study compared masticatory performance of
young and elderly adults with complete natural dentition. Elderly adults
had a lower masticatory performance than that of young adults, but the dif
ference was not significant. Moreover, no significant relationship between
age and masticatory performance was found in either of the groups. As this
result differed from that of occlusal force, it is considered that mastication
is not performed using maximum muscle force [24]. Even if there is a
decrease in muscle force with age [6,14], it can be assumed that since the
muscle force required for mastication can be exerted fully, there was no
significant decrease in masticatory performance. Therefore, masticatory
performance can be maintained with a complete natural dentition.
In this study, only 76 elderly adults (35 males and 43 females) were
analyzed because the selection condition of the study was to have a
complete natural dentition. Therefore, further investigations with a larger
sample are warranted.
Conflict of interest
The authors declare that they have no conflict of interest.

References