

The relationship between dysphagia, oral health, masticatory performance and activities of daily living in elderly individuals as assessed by the Eating Assessment Tool

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Summary. *Aim:* Poor oral health and tooth loss can lead to a reduction in masticatory performance and activities of daily living (ADL) and affect swallowing. The plan for this study was to determine the relationship between the oral health status, masticatory performance and ADL of elderly individuals with dysphagia and without dysphagia. *Methods:* The study population consisted of 55 elderly persons with dysphagia (27 male) and 62 elderly persons (24 male) without dysphagia. Dysphagia assessed by Eating Assessment Tool (EAT-10), the ADL was determined by the Barthel Index (BI) and the oral health status was determined by the Geriatric Oral Health Index (GOHAI). The masticatory performance was evaluated by using a color-changeable chewing gum. *Results:* Of the dysphagic participants, 69.1% had poor, 27.3% had normal and 3.6% had good masticatory performance ($P < .05$); 90.9% had severe and 9.1% had moderate oral health problems ($P < .001$). There was a strong correlation between the GOHAI and EAT-10 scores and a moderate correlation between the GOHAI, masticatory performance and BI scores in the dysphagic individuals ($P < .05$). *Conclusion:* Poor oral health and decreased masticatory performance are directly associated with dysphagia and may lead to a decrease in ADL. When oral health improves or dental treatment is provided, the swallowing function, nutritional status and ADL may improve in elderly individuals. Further studies should evaluate the effect of oral health and masticatory performance on ADL and their efficacy in dysphagia in the long term.

Keywords: dysphagia, elderly, oral health, masticatory performance, ADL

Introduction

Dysphagia is a general health problem but it affects more people in the elderly population (1). Dysphagia is associated with mortality (2), aspiration pneumonia (3), malnutrition, dehydration (4), and reduced activity of daily living (ADL) (5). With aging, one of the most important changes leading to dysphagia is the decrease in the ADL as the skeletal muscles and smooth muscles of the face lose strength so these changes reduced chewing ability and nutrient intake (6). In the oral phase of swallowing; the lips, tongue, jaw, and teeth are essential for preparing a bolus for chewing. Because the lips are

closed, the movements of the jaw are essential for this phase and the tongue senses the bolus. When the bolus is ready for swallowing, it is placed behind the tongue for ejection. Therefore, the sensitivity, mobility, and strength of the tongue are important. In the pharyngeal phase, there is a palatal increase and contraction of the posterior wall of the pharynx. The bolus slides into the laryngopharynx for both expansion and elevation. Hence, the orofacial functionality is crucial for adequate swallowing (7). During aging, the swallowing mechanism and oral mucosa change, and the muscles lose their mobility, strength, and sensitivity (8). Elderly individuals often have difficulty in swallowing because

of decreased orofacial hypotonic muscle tone and varying chewing function (9). In addition, decreased jaw strength and saliva production, loss of teeth or impaired teeth, and changes in the adipose tissue connections of the tongue adversely affect the swallowing process (10). Tooth loss becomes more common, especially around the seventh decade of life (11). The effect of tooth loss on chewing in the elderly has been shown in the literature (12-14), but there are few studies evaluating the relationship between oral health and swallowing function (15,16) and the available evidence is inadequate. The masticatory performance can generally be subjectively evaluated by observing the chewing of any food (17), but this is not a practical method. Another popular method is to measure an individual's ability to grind or pulverize a test food by chewing it (18). In recent years, color-changeable chewing gum has been used and become the gold standard instead of test foods (19-21). The masticatory performance based on the mixing ability as well as the grinding ability can be evaluated with the color-changeable chewing gum (21). The changes in the color value of the gum reliably reflects the masticatory performance of individuals with natural teeth or dentures (21). A color scale was developed for the visual evaluation of the gum to evaluate the masticatory performance (22). In an article published in 2017, it was reported that color-changeable gum was reliable for measuring the masticatory performance of the elderly people (18). However, its validity in elderly people with dysphagia has not been investigated. Therefore, the aim of this study was to evaluate the masticatory performance by using color-changeable gum and assessing the ADL and oral health status of elderly individuals with and without dysphagia.

Material and methods

Study Design and Selection of Participants

This was a descriptive and cross-sectional study including case and control groups. The study population consisted of 55 volunteer elderly participants with dysphagia (27 male and 28 female) who consulted the Hacettepe University Swallowing Disorders Research and Application Center and 62 volunteer elderly par-

ticipants (24 male and 38 female) without dysphagia attending the Geriatric Polyclinic in Turkey between April 2015-2016. Individuals aged <65 years or with special nutrition conditions were excluded.

Written approval to use the document about demographic characteristics, Eating Assessment Tool, Barthel Index and Geriatric Oral Health Assessment Index was secured, and ethical approval was obtained from the Noninvasive Clinical Research Ethics Committee (Approval number: GO 15/265) at Hacettepe University. Written and verbal informed consent was obtained from all subjects.

Data on demographic characteristics, comorbidities and ADL, masticatory performance, and oral health were obtained by interview and examination.

Evaluation of Dysphagia

The dysphagia risk was evaluated by the Eating Assessment Tool (EAT-10). Belafsky et al. (23) developed the 10-item questionnaire for dysphagia screening. Each item is scored from 0 to 4, with a score of 0 indicating no problem and a score of 4 indicating a severe problem. An EAT-10 score of 3 or higher is abnormal and indicates the presence of swallowing difficulties.

Assessment of Oral Health Status

The oral health status was assessed with the Geriatric Oral Health Assessment Index (GOHAI). Atchinson and Dolan (24) developed the GOHAI in 1990 to measure the oral health status in elderly individuals. The scale is divided into 12 questions on 3 main topics and it determines the following parameters: physical functions (e.g., eating, swallowing and speaking), psychological functions and behavioral effects (e.g., concern or anxiety about oral health, external appearance, self-confidence and social communication), and pain and discomfort (e.g., discomfort while eating and drug use).

Assessment of the ADL

The Barthel Index (BI) was used to assess the ADL of the elderly individuals. The index was first developed in 1965 (25), and the version used today was developed by Granger et al (26). The index consists of 10 questions, and these questions have subtitle questions and scores.

Assessment of Masticatory Performance

The masticatory performance was assessed by color-changeable gum, called “XYLITOL”, (70 9 20 9 1 mm 3; 3.0 g; Masticatory Performance Evaluating Gum XYLITOL, Lotte, Tokyo, Japan). Color-changeable gum was developed specifically to evaluate a person’s masticatory performance; and it changes color as it is chewed (21). Also, using the gum is not a disadvantage for elderly people with prosthetic teeth. The gum was chewed 100 times by the elderly participants with dentures and 60 times by the elderly participants with their own teeth. The masticatory performance was evaluated as poor, normal, or good with the improved color scale (22).

Statistical Analysis

Study data were evaluated with the statistical program SPSS 23.0 (Statistical Package for the Social Sciences, Inc., Chicago, Illinois, United States). Quantitative variables were expressed as the mean±SD (standard deviation), and differences were analyzed by

the student’s t-test or Mann-Whitney U-test, as appropriate. Categorical data were expressed as the frequency (percentage), and differences were analyzed using the Fisher’s exact test (when including any expected value ≤ 5) or the chi-square test. The results were reported with a 95% confidence interval, and $P < .05$ was considered statistically significant.

Results

General Characteristics of Participants

General characteristics of the participants are given in Table 1. Demographic variables, including marital status, residence (i.e., whether the participant was living with family) and total education time, were found to be similar in both groups ($P > .05$). In the dysphagic group, all of the participants had other comorbidities. The most common diseases in the dysphagic and control groups were neurological disorders; and values were 58.2% and 22.6%, respectively (Table 1).

Table 1. General characteristics of the elderly persons

	Dysphagic Group (n:55) n (%)	Control Group (n:62) n (%)	P value
Age (years)[†]	71.01±7.27	72.29±6.8	0.867
Sex			0.270
Male	27 (49.1)	24 (38.7)	
Female	28 (50.9)	38 (61.3)	
Marital status			0.388
Single	-	2 (3.2)	
Married	39 (70.9)	41(66.1)	
Divorced	16 (29.1)	19 (30.6)	
Residential dwelling			0.980
Living alone	4 (7.3)	12 (19.4)	
Together with a family member	51 (92.7)	50 (80.6)	
Total education time (year)[†]	9.29±4.53	9.28±4.09	0.865
Co-morbidities[§]			
Neurological diseases	32 (58.2)	14 (22.6)	0.340
Stroke	18 (32.7)	-	0.023*
Cardiovascular diseases	16 (29.1)	20 (30.2)	0.687
Diabetes Mellitus	16 (29.1)	28 (54.2)	1.00
Hypertension	30 (50.0)	43 (69.4)	0.004*
ALS	10 (18.2)	-	0.023*
Hyperlipidemia	10 (18.2)	25 (40.3)	0.104

* $p < .05$, § Values calculated more than one disease or supplement in the same patient., † Mean±SD, ALS: Amyotrophic Lateral Sclerosis

Test Scores in Elderly Persons

Of the dysphagic participants, 69.1% had poor, 27.3% had normal and 3.6% had good masticatory performance; in the control group, these values were 53.2%, 30.6% and 16.1%, respectively ($P < .05$). In the dysphagic group, 90.9% had severe and 9.1% had moderate oral health problems; in the control group, these values were 29.0% and 35.5%, respectively, and 35.5% had no oral health problems ($P < .001$). Regarding the status of ADL, 56.4% of the group with dysphagia and 56.5% of the control group were moderately dependent (Table 2).

No significant correlation was observed in the control group in terms of the used tests with the elderly. In the dysphagic group, the strongest correlation was found between the GOHAI and EAT-10 and a moderate correlation was found between the GOHAI, masticatory performance and the BI and between the EAT-10 and BI (Table 3).

Discussion

This study is the first cross-sectional study to assess differences between masticatory performance, oral health problems, and ADL in elderly individuals with or without dysphagia in Turkey. Regarding masticatory performance, 69.1% had poor, 27.3% had normal, and 3.6% had good masticatory performance. Regarding oral health in the dysphagic individuals, 90.9% had severe and 9.1% had moderate oral health problems. There was a strong correlation between the GOHAI and EAT-10, a moderate correlation between the GOHAI, masticatory performance and the BI and a weak correlation between BI and masticatory performance in the dysphagic group.

Dysphagia is associated with a decrease in ADL in elderly individuals. Some neurological diseases cause both dysfunction of the extremities and dysphagia. In a similar study, the BI score was lower in the elderly with high EAT-10 scores (5). In this study, the

Table 2. Masticatory performance, EAT-10, GOHAI and BI tests score of the elderly persons

	Dysphagic Group (n:55) n (%)	Control Group (n:62) n (%)	P value
Number of teeth			
Natural teeth†	6.49±8.82	10.64±11.358	0.405
Denture†	22.27±13.21	17.87±13.21	0.005*
Masticatory Performance (n,%)			0.039*
Poor	38 (69.1)	33 (53.2)	
Normal	15 (27.3)	19 (30.6)	
Good	2 (3.6)	10 (16.1)	
EAT-10 score (n,%)			<0.001*
≥3 (risk of dysphagia)	55 (100.0)	-	
<3 (no risk of dysphagia)	-	62 (100.0)	
BI score (n,%)			0.051
0-20 (severe dependent)	1 (1.8)	-	
21-61 (highly dependent)	12 (21.8)	4 (6.5)	
62-90 (moderate dependent)	31 (56.4)	35 (56.5)	
91-99 (less dependent)	7 (12.7)	12 (19.4)	
100 (independent)	4 (7.3)	11 (17.6)	
GOHAI Score (n,%)			<0.001*
<51(severe problem)	50 (90.9)	18 (29.0)	
51-56 (moderate problem)	5 (9.1)	22 (35.5)	
≥57 (no problem)	-	22 (35.5)	

* $p < .05$, † Mean±SD, EAT-10: Eating Assessment Tool, BI: Barthel Index, GOHAI: Geriatric Oral Health Assessment Index

Table 3. The relationship between the tests used to the elderly persons (r)

Dysphagic Group	GOHAI	EAT-10	BI	Masticatory Performance
GOHAI	-			
EAT-10	r= -0.739*	-		
BI	r= 0.402**	r= -0.342*	-	
Masticatory Performance	r= 0.504*	r= -0.267**	r= 0.323**	-
Control Group				
GOHAI	-			
EAT-10	r= -0.134	-		
BI	r= 0.238	r= 0.140	-	
Masticatory Performance	r= 0.238	r= 0.140	r= 0.091	-

*p< .001, ** p< .05 , EAT-10: Eating Assessment Tool, BI: Barthel Index, GOHAI: Geriatric Oral Health Assessment Index

majority of the elderly with dysphagia had a neurological disease (58.2%) and a moderate relationship was found between the EAT-10 and BI scores. Overall, the participants (56.4% of the dysphagic group and 56.5% of the control group) were moderately dependent, but this was not found to be statistically significant. The reason for this is that the decrease in ADL may be due to other diseases and the aging process can cause dysphagia independently.

Poor oral health can promote the development of aspiration pneumonia due to dysphagia by increasing the number of bacteria in saliva (27). There is limited evidence to assess the relationship between oral health and swallowing function. In one study, GOHAI scores were lower in patients with dysphagia (28). In another study, poor oral health was reported to be associated with sarcopenia, malnutrition, and decreased ADL in elderly individuals (29). In this study, it was observed that 90.9% had severe and 9.1% had moderate oral health problems in the dysphagic group, and these rates were 29.0% and 35.5% in the control group, respectively. There was no oral health problem in 35.5% of the elderly in the control group. A strong relationship was found between the GOHAI and EAT-10 scores, which clearly show a link between oral health and dysphagia.

Another cause of poor oral health is tooth loss. In this study, the dysphagic participants had significantly more dentures than the control group (Table 2). Tooth loss causes changes in the anatomy of the oral cavity. It affects the oral phase of swallowing and thus, impairs other phases. Tooth loss reduces the masticatory perfor-

mance and causes difficulties in the formation of a bolus, which may be larger and interfere with other swallowing efforts (30). Tooth loss in the elderly increases dysphagia and can initiate disabilities and even lead to mortality (31). The results of the studies showed that tooth loss was associated with a decrease in ADL (16,32). In one study, a direct correlation was found between dysphagia and BI scores; it also showed that replacement of lost teeth helped to ameliorate dysphagia (33). Another study reported a strong relationship between oral health status, dysphagia, and ADL and after oral treatment, dysphagia improved in three patients (34). Dentures can improve masticatory performance, nutritional status, and ADL by improving swallowing function in elderly patients (33). In this study, although more of the dysphagic elderly had dentures and the masticatory performances were found to be lower (Table 2). This may have been due to more occlusion disorders in the dysphagic group or decreased jaw strength due to muscle loss and decreased masticatory performance. In addition, there was a weak correlation between BI and masticatory performance. This may be due to the fact that most of the participants are moderately dependent.

It is important to provide healthy nutrition for the elderly; oral health, swallowing, and masticatory performance should be evaluated periodically. Foods used to evaluate masticatory performance should not have a sticky structure or be difficult to be affected by saliva when chewed. The foods should also remain stable when stored at room temperature (35). Therefore, it is difficult and time consuming to evaluate masticatory performance with a food. Color-changeable gum

is easy to use and can be applied even in the home environment without the need of a specialist. In a study evaluating the use of color-changeable gum in the elderly, the validity of its use in this group was also determined (18). This study demonstrated the suitability of using the gum in elderly people with dysphagia. In addition, the masticatory performance was found to be lower in the dysphagic group, with the reason being that decreased jaw performance and tooth loss directly affect the masticatory performance. Because the study participants were elderly, it was generally expected that their masticatory performance would be poor.

This study had some limitations. First, the study was cross-sectional, so it is difficult to examine the causality relationship. Second, the oral health status of the participants was assessed subjectively by personal assessment (GOHAI), and no objective assessment was made by a dentist.

In conclusion, poor oral health and decreased masticatory performance are directly associated with dysphagia and may lead to a decrease in ADL. Improving oral health or providing dental treatment can improve the swallowing function, nutritional status, and ADL in elderly individuals. Further studies should evaluate the effect of oral health and masticatory performance on ADL and their efficacy in dysphagia in the long term.

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Conflict of Interest: The authors declare no conflict of interest

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