Evaluation of some factors affecting taste perception in elderly people

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Summary

There are many physiological changes in elderly people that affect the quality of life. One of these changes takes place in sensory organs, which also have manifestations in the oral cavity. Alteration in taste perception is very important since it influences dietary habits and general health. Here we investigated the effects of some factors on gustatory function – such as gender, smoking, denture use and dietary habits with respect to spicy food consumption – in a group of elderly people. 18 elderly subjects (mean age 65.1) were included in the study and whole-mouth, above threshold test and a spatial (localized) taste tests were performed using four basic tastes (sweet, salt, sour and bitter). There were no statistically significant differences in the threshold for four basic tastes considering the investigated parameters. However, for the spatial test, male subjects had significantly impaired palatal perception for sour and salty tastes and denture users had significantly enhanced palatal perception for sour taste.
The results of this study showed impairment of taste perception in elderly people concerning gender and denture use. We suggest further studies to investigate the effects of different factors on gustatory function in the elderly.

Key words: taste function, elderly people, smoking, dietary habit, denture.

Introduction

The sense of taste is one of the most important human senses. It gives an individual the ability to recognise consumables that are encountered in daily life; however, after a particular age, there is a disorder in the sense of taste, which can result in potentially dangerous conditions such as malnutrition or susceptibility to diseases. When elderly people try to live with a weakened ability to recognise certain food flavours or any other consumable item, their dietary needs can be greatly affected. A certain number of foods are not going to taste good enough to satisfy the appetites of the elderly, so they may gain unhealthy dietary habits. This change in dietary habits can result in some health problems such as loss in bone mass, deficiency in immune system, high blood pressure and weakness of the musculo-skeletal system. There are many physiological as well as external factors that can affect the gustatory function in elderly people. Geriatric dentistry is an important field of dental practice and a general dental practitioner should be aware of the physiological changes in the elderly to enhance the outcome of treatment and the living standard of elderly patients.

The aim of this pilot study was to evaluate the influences of some factors such as gender, smoking, denture use, and dietary habits with respect to spicy food consumption, which we think are important on gustatory function in elderly people.

Material and Methods

Eighteen patients admitted to Ankara University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery for routine dental treatment were enrolled for the study. All subjects taking part in the study were required to fulfil the following criteria: not be taking any medication, have good oral hygiene, not have any dental or systemic disease and history that could affect gustatory function [1]. All measurements were recorded in the late morning or after-

noon at least one hour after each patient had finished eating or smoking. Dentures, if worn, were removed immediately before the tests.

To taste gustatory function, two tests were carried out: a whole-mouth, above threshold test and a spatial (localized) taste test. For these tests, sucrose (sweet), sodium chloride (salty), citric acid (sour) and quinine hydrochloride (bitter) solutions were used. Informed consent was obtained from all the participants.

Whole-mouth, above threshold taste test

For this test, the patient was instructed in the use of magnitude estimation to rate the intensity of each stimulator solution. Five concentration levels (in 1/2 log steps) of sodium chloride (0.01 mol/L-1.0 mol/L), citric acid (0.32 mmol/L-0.032 mol/L), quinine hydrochloride (0.01 mmol/L -1.0 mmol/L) and sucrose (0.01 mol/L-1.0 mol/L) were prepared in 5 ml samples, which the patient sipped and then expectorated. The solutions were given in increasing concentrations respectively. The patient was then asked to identify the quality (sweet, salty, sour, bitter, or tasteless) and intensity of each test solution. The threshold of each solution was determined.

Spatial (localized) taste test

Each patient was also tested on localized taste function. This test consists of identifying the quality of each test stimulus and rating the stimulus on an intensity scale from 0 (no taste) to 9 (very strong taste). In each trial, the strongest concentration of one of the four compounds used in the whole-mouth taste test was painted with a cotton swab on one of six locations in the mouth: the right and left anterior and posterior-lateral surfaces of the tongue (within the receptive field of the chorda tympani-lingual nerve) and the two sides of the soft palate, lateral to midline (within the receptive field of the palatal nerve).

To prevent any bias in both tests, the order in which each solution was to be taken, and the order of the localisation for painting were determined randomly. All the tests were done at the same visit, and to minimise fatigue or lack of attention, all participants were allowed to take periodic rest breaks. Each patient was studied by only one observer.

Statistical analysis

Mann-Whitney U test was used with acceptance of a probability of $p < 0.05$ as significant.

Results

Nine of the participants were male (50%) and 9 were female (50%). Age ranged 55 to 76 with a mean of 65.1. The scores of the whole-mouth

Table 1. Total taste intensity ratings from whole-mouth test (Mean ± Standard Deviation)

	Tested solution			
	Sucrose	**NaCl**	**Citric acid**	**Quinine hyd.**
Gender				
Male	3.67 ± 0.87	2.89 ± 0.93	3.44 ± 0.88	3.89 ± 0.93
Female	2.67 ± 1.22	2.67 ± 1.12	3.89 ± 0.78	3.56 ± 1.13
p value	0.77	0.73	0.34	0.48
Smoking				
Smokers	3.25 ± 2.22	2.5 ± 1.00	3.25 ± 0.50	4.00 ± 1.15
Non-smokers	3.14 ± 0.77	2.86 ± 1.03	3.79 ± 0.89	3.64 ± 1.01
p value	0.38	0.57	0.27	0.64
Denture				
Users	2.75 ± 1.49	2.63 ± 0.92	3.38 ± 0.74	3.50 ± 0.93
Non-users	3.50 ± 0.71	2.90 ± 1.10	3.90 ± 0.88	3.90 ± 1.10
p value	0.20	0.46	0.31	0.46
Spicy food				
Consumers	2.80 ± 1.92	2.80 ± 1.10	3.60 ± 0.89	3.00 ± 0.00
Non-consumers	3.31 ± 0.75	2.77 ± 1.01	3.69 ± 0.85	4.00 ± 1.08
p value	0.70	0.92	0.77	0.09

threshold test for all parameters were given in *Table 1* and the scores for spatial test for four basic tastes (sucrose, sodium chloride, citric acid, quinine hydrochloride respectively) were given in *Table 2*, *Table 3*, *Table 4* and *Table 5*.

There was no statistically significant difference between male and female subjects in the threshold for four basic tastes ($p > 0.05$). However, there was a significant reduction in palatal perception of salt and sour for men ($p < 0.05$), whereas there was no significant difference in tongue scores for both sexes ($p > 0.05$). Four patients were smoking cigarette (22.2%) and 14 were non-smokers (77.8%). There was no significant difference in

Table 2. Total taste intensity ratings from spatial taste function for Sucrose (Mean ± Standard Deviation)

	Tested region					
Gender	**Right ant. tongue**	**Right post. tongue**	**Left ant. tongue**	**Left post. tongue**	**Right palate**	**Left palate**
Male	3.78 ± 2.99	4.22 ± 2.77	3.78 ± 2.99	3.78 ± 3.15	3.89 ± 3.10	4.00 ± 3.20
Female	3.00 ± 3.50	2.78 ± 3.35	3.00 ± 3.50	3.44 ± 3.75	3.00 ± 3.97	2.78 ± 3.83
p value	0.66	0.29	0.66	0.86	0.54	0.43
Smoking						
Smokers	2.50 ± 2.89	4.25 ± 2.99	2.50 ± 2.89	3.00 ± 3.56	2.50 ± 3.79	2.50 ± 3.79
Non-smokers	3.64 ± 3.32	3.29 ± 3.17	3.64 ± 3.32	3.79 ± 3.42	3.71 ± 3.50	3.64 ± 3.50
p value	0.50	0.57	0.50	0.72	0.57	0.57
Denture						
Users	2.75 ± 3.49	3.25 ± 3.20	2.75 ± 3.49	2.63 ± 3.29	1.88 ± 3.23	1.88 ± 3.23
Non-users	3.90 ± 3.00	3.70 ± 3.13	3.90 ± 3.00	4.40 ± 3.37	4.70 ± 3.30	4.60 ± 3.34
p value	0.40	0.76	0.40	0.31	0.10	0.10
Spicy food						
Consumers	3.60 ± 3.91	3.40 ± 3.78	3.60 ± 3.91	2.40 ± 3.91	4.20 ± 4.55	4.20 ± 4.55
Non-consumers	3.31 ± 3.04	3.54 ± 2.93	3.31 ± 3.04	4.08 ± 3.17	3.15 ± 3.16	3.08 ± 3.15
p value	0.92	0.92	0.92	0.38	0.63	0.63

Table 3. Total taste intensity ratings from spatial taste function for NaCl (Mean ± Standard Deviation)

	Tested region					
Gender	**Right ant. tongue**	**Right post. tongue**	**Left ant. tongue**	**Left post. tongue**	**Right palate**	**Left palate**
Male	4.67 ± 3.08	5.56 ± 2.35	4.67 ± 3.08	5.11 ± 2.47	5.89 ± 2.57	5.89 ± 2.57
Female	2.44 ± 3.75	2.78 ± 4.21	2.44 ± 3.75	4.56 ± 4.39	1.89 ± 3.14	3.67 ± 3.87
p value	0.13	0.13	0.13	0.86	**0.01**	0.22
Smoking						
Smokers	3.50 ± 3.32	3.00 ± 2.45	3.25 ± 3.40	2.75 ± 2.50	4.50 ± 2.52	4.50 ± 2.52
Non-smokers	3.57 ± 3.69	4.50 ± 3.88	3.64 ± 3.67	5.43 ± 3.55	3.71 ± 3.75	4.68 ± 3.68
p value	0.95	0.44	0.95	0.15	0.72	0.72
Denture						
Users	4.38 ± 3.34	3.87 ± 3.76	4.38 ± 3.34	3.50 ± 3.55	4.00 ± 3.30	4.00 ± 3.30
Non-users	2.90 ± 3.70	4.40 ± 3.66	2.90 ± 3.70	5.90 ± 3.18	3.80 ± 3.77	5.40 ± 3.50
p value	0.36	0.82	0.36	0.20	0.76	0.46
Spicy food						
Consumers	2.40 ± 3.91	2.40 ± 3.91	2.40 ± 3.91	3.80 ± 4.09	3.00 ± 3.94	4.80 ± 4.27
Non-consumers	4.00 ± 3.42	4.85 ± 3.39	4.00 ± 3.42	5.23 ± 3.30	4.23 ± 3.37	4.77 ± 3.19
p value	0.44	0.24	0.44	0.50	0.50	0.92

bold numbers: statistically significant

scores of either test for smokers and non-smokers ($p > 0.05$). Eight patients were using upper and lower removable partial or full dentures (44.4%) and 10 patients were full dentate patients (55.6%).

There was no significant difference between denture users and non-users in the threshold for four basic tastes ($p > 0.05$) but there was a significant enhancement of sour perception in the palatal region for maxillary denture using patients ($p < 0.05$). Five participants reported that they generally consume spicy food and frequently use spices in their meals (27.8%) and thirteen reported no such preference (72.2%). There was no significant difference in either test score when spicy food consumption was considered ($p > 0.05$).

Table 4. Total taste intensity ratings from spatial taste function for Citric acid (Mean ± Standard Deviation)

	Tested region					
Gender	**Right ant. tongue**	**Right post. tongue**	**Left ant. tongue**	**Left post. tongue**	**Right palate**	**Left palate**
Male	3.56 ± 2.51	2.89 ± 2.47	3.56 ± 2.51	2.89 ± 2.47	4.89 ± 2.98	4.89 ± 2.98
Female	1.33 ± 2.83	3.11 ± 3.92	1.67 ± 3.08	2.89 ± 3.92	0.78 ± 2.33	1.00 ± 2.96
p value	0.77	1.00	0.11	0.79	**0.006**	**0.05**
Smoking						
Smokers	4.25 ± 3.10	1.75 ± 2.06	4.75 ± 2.22	2.25 ± 1.71	3.50 ± 2.38	4.00 ± 1.41
Non-smokers	1.93 ± 2.64	3.36 ± 3.41	2.00 ± 2.83	3.07 ± 3.52	2.64 ± 3.63	3.29 ± 3.63
p value	0.19	0.44	0.07	0.87	0.72	0.72
Denture						
Users	1.50 ± 2.14	2.38 ± 2.77	1.75 ± 2.05	2.63 ± 2.62	1.25 ± 2.05	1.50 ± 2.00
Non-users	3.20 ± 3.19	3.50 ± 3.54	3.30 ± 3.37	3.10 ± 3.70	4.10 ± 3.73	5.00 ± 3.27
p value	0.27	0.57	0.36	0.96	0.14	**0.02**
Spicy food						
Consumers	2.40 ± 3.58	3.20 ± 3.35	3.00 ± 3.74	2.80 ± 3.35	2.20 ± 3.19	2.60 ± 2.97
Non-consumers	2.46 ± 2.67	2.92 ± 3.25	2.46 ± 2.67	2.92 ± 3.25	3.08 ± 3.50	3.77 ± 3.39
p value	0.77	0.84	0.84	0.92	1.00	0.56

bold numbers: statistically significant

Table 5. Total taste intensity ratings from spatial taste function for Quinine hydrochloride (Mean ± Standard Deviation)

	Tested region					
Gender	**Right ant. tongue**	**Right post. tongue**	**Left ant. tongue**	**Left post. tongue**	**Right palate**	**Left palate**
Male	3.33 ± 3.43	2.89 ± 2.98	3.33 ± 3.43	2.89 ± 2.98	4.67 ± 3.54	3.67 ± 3.43
Female	3.00 ± 3.91	1.89 ± 3.76	3.00 ± 3.91	1.89 ± 3.76	3.00 ± 3.74	3.56 ± 4.00
p value	0.86	0.48	0.86	0.48	0.25	0.86
Smoking						
Smokers	3.75 ± 2.63	4.00 ± 2.83	3.75 ± 2.63	4.00 ± 2.83	2.75 ± 2.22	3.00 ± 1.83
Non-smokers	3.00 ± 3.86	1.93 ± 3.41	3.00 ± 3.86	1.93 ± 3.41	4.14 ± 3.96	3.79 ± 4.02
p value	0.72	0.32	0.72	0.32	0.64	0.95
Denture						
Users	3.38 ± 3.89	0.88 ± 1.64	3.38 ± 3.89	0.88 ± 1.64	3.00 ± 3.42	3.13 ± 3.31
Non-users	3.00 ± 3.50	3.60 ± 3.89	3.00 ± 3.50	3.60 ± 3.89	4.50 ± 3.84	4.00 ± 3.97
p value	0.89	0.20	0.89	0.20	0.36	0.33
Spicy food						
Consumers	4.00 ± 4.06	0.80 ± 1.79	4.00 ± 4.06	0.80 ± 1.79	3.80 ± 3.77	4.00 ± 3.54
Non-consumers	2.85 ± 3.48	3.00 ± 3.63	2.85 ± 3.48	3.00 ± 3.63	3.85 ± 3.74	3.46 ± 3.78
p value	0.56	0.33	0.56	0.33	0.84	0.77

Discussion

Age-related changes occur in various sensory organs. Oral changes with ageing can have a significant effect on the efficacy of dental treatment. Among these changes are low levels of taste and smell perceptions that can make foods become tasteless and result in a decline in appetite [2]. Food intake decreases with age, and this lower intake leads to a loss of body weight and in turn to an increased risk of nutrition-related illness. There are several possible causes for this low food intake, one of them being a decreased appetite due to psychological factors or physiological factors such as sensory impairment.

There have been a number of studies that have searched for possible causes and solutions to taste loss in ageing people. Some researchers have looked for causes of taste loss in the elderly by focusing on the biological changes that occur in the mouth such as impaired taste abilities or sensory deficits in the tongue, while others have looked for causes of taste loss by focusing on the effect of external factors such as smoking, denture use and dietary habits. The sensitivity of the tongue has been a great interest for researchers dealing with taste loss in the elderly. Some have alleged that the taste deficit could be related to the number of taste buds that a person loses on the surface of the tongue when they reach a certain age [2-4]. Hendericks et al. [5] noted that the number of taste buds on the tongue stays constant until the age fifty when their numbers begin to decline. When this happens, any certain number of taste buds could be lost, thus causing a decrease in taste ability. Miller [6] found that taste bud density does not really diminish with age, but rather stays at an equal level based on person's individual health. This shows that there may be a close relation between a person's general health and taste sensitivity. While some researchers focus on the decline of taste buds as a possible cause for the loss in taste ability, Spence [7] mentioned that a reduction in saliva could interfere with a dissolving food reaction with a receptor cells on the tongue. This information could explain why some foods taste dry to some elderly individuals.

Only a few studies investigated differences by age and sex in taste thresholds measured at different loci in the mouth. Some of these studies found a difference in thresholds by age and sex whereas others did not. Different reported results may be due to different concentrations of the solutions and the techniques used for taste test and also to the points stimulated in the mouth. Yamauchi et al. [8] reported significant age-related changes for salty, sour and bitter taste. The results of Murphy's analysis [9] showed that taste thresholds do increase slightly with age, although not to the extent described in earlier reports in the literature. Studies from Japan and the USA reported that slight elevations of the thresholds for the four basic tastes occur with increasing age although the amount of elevation differs for each taste. Our recent article [10] showed a decline in palatal sensitivity for sweet taste in postmenopausal women compared to age-matched men. In this study, we only found increased threshold for palatal perception for salt and sour tastes in elderly men.

There are some other factors besides ageing that can contribute to a gradual loss of taste in the elderly. Some external factors that can affect the mouth have been suspected of or known to cause taste buds to decline in number. Smoking, for example, has been suspected of either inhibiting or destroying the mouth ability to function properly. Hsu and David [11] found that smoking along with certain diseases could decrease gustatory sensitivity. Peterson et al. [12] and Yamauchi et al. [8] found higher thresholds among smokers compared to non-smokers for bitter taste only, and Jackson [13] reported that recognition of salty taste deteriorated among subjects who smoked at least 40 cigarettes per day. Sato et al. [14] found that taste threshold on the soft palate was higher for all four basic tastes among smokers of both sexes. They also concluded that impact of smoking on taste thresholds could develop first in the soft palate, probably due to the smaller number of taste buds in the soft palate. On the basis of different results, one may infer that even if smoking does have a negative effect on taste perception, the effect is probably slight and is most likely to affect bitter taste. In contrast, Moore et al. [15] and Fisher et al. [16] reported no significant difference between smokers and non-smokers. In this study, we did not find any difference between smokers and non-smokers either, but we suggest further studies investigating the relation between different smoking habits (i.e. pipe smoking, reverse

smoking, smokeless tobacco etc.) and taste alteration.

Reports in the literature suggest that dentition influences taste perception [17]. There is evidence in the literature that dentition status, chewing and swallowing ability are correlated in the sense that persons with full dentures are having more problems with chewing and swallowing. Elderly people with these problems shift to dietary restrictions [18]. There are some studies indicating a change in taste perception in denture using patients. Here we found that denture-using patients had enhanced palatal perception for sour taste. This may be due to the sour metallic taste of the metal-supported denture base, which the patient gradually gets used to or to the galvanic current induced by metal interaction in the mouth.

Dietary habit is an important factor on taste perception. Excessive consumption of certain flavours may affect taste sensitivity [19]. In our country, spicy food consumption is a common tradition among all age groups and in all regions; therefore, we wanted to investigate the effect of dietary habits with respect to spicy food consumption on taste perception. Although we did not find any significant correlation, there is need for more detailed research about different dietary habits and taste sensitivity. As shown in our study, there is a decline in palatal sensitivity for salty and sour tastes in elderly men. Geriatric patients should be advised to use seasonings to their food instead of excessive consumption of salt and sour to give their food flavour. Excessive intake of salt and sour will cause serious problems particularly for those with high blood pressure and gastrointestinal system problems.

Researches may have found several possible causes as to why taste deteriorates in an ageing person, but a treatment for the problem still remains unsolved. Schiffman [20] mentioned that there are no proven pharmacological methods to treat age-related chemosensory problems and the prognosis for the recovery of smell and taste sensations is poor. In order to make the taste of food more enjoyable, treating the tongue may not be the solution. The result of our study also supports this statement, because the taste sensitivity did not deteriorate in the tongue but in the palate of elderly people.

The age-related taste changes are still a big problem for the elderly around the world and will continue to be in the future as the population of elderly people is increasing parallel to increased life expectation. If more research is conducted on this problem, then the chances of finding a better way to improve taste functioning in the elderly could occur.

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