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Evaluation Method of Saliva Composition and Taste Function in the Elderly: A Critical Review of Differences in Taste Test Results

Yihan Hou

Business School, The University of Sydney, Sydney, Australia
yhou0673@uni.sydney.edu.au

Abstract. With the deepening of population ageing, the loss of taste in the elderly and its impact on diet, nutrition and quality of life are gradually attracting attention. However, the evaluation results of the taste function of the elderly in existing studies are not exactly consistent. This difference may be due not only to the physiological ageing of the elderly, but also to salivation and component changes, oral function and test methods. This paper adopts a critical literature review method to analyze the physiological changes such as saliva flow rate, protein, mucoprotein and glycosylation in the elderly, and compares the principles, clinical applications and result differences between the solution-type taste test and the taste test paper test. At the same time, this article examines the confounding factors such as dental condition, denture use, swallowing function and oral environment, as well as the limitations of in vitro research and observational clinical research. The study found that the taste changes of the elderly cannot be simply attributed to age, and changes in saliva quality, differences in oral function and the measurement characteristics of evaluation tools may also affect the test results. Therefore, the taste evaluation of the elderly should be combined with a variety of test methods, saliva function examination and individual oral condition for comprehensive judgement. Future research also needs to unify test standards, carry out longitudinal research on larger samples, and explore oral care strategies for saliva function and individual needs.

Keywords: ageing, taste function, salivary function, taste assessment

1. Introduction

Taste is an important sensory function of the human body to recognize the nature of food, form dietary preferences and maintain normal nutritional intake. With the increase of age, some elderly people will have a decrease in taste sensitivity, a weak taste discrimination ability or a change in food flavor experience. These changes may reduce appetite and pleasure of eating, increasing the risk of unbalanced diet, malnutrition, and declining quality of life. Senile loss of taste is often called "presbygeusia", but the existing evidence cannot prove that loss of taste is an inevitable result of normal ageing. Changes in the structure of taste buds, function of the central nervous system, saliva

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composition, oral microorganisms, chronic diseases and drug use may also be involved in changes in the taste of the elderly [1].

Existing studies use a variety of methods to evaluate the taste function of the elderly, among which solution-based taste test and taste test paper test are widely used. However, there are differences between the two methods in terms of stimuli carrier, concentration setting, contact range and scoring method, and the research results are not the same. If factors such as saliva function, dental condition, denture use and swallowing ability are ignored, the test results may be misinterpreted as a simple age effect. Therefore, this article adopts a critical literature review method to analyze the physiological changes of saliva in the elderly, compare the two main taste evaluation methods, and discuss the oral and methodological factors that affect the test results. This article aims to explain the possible mechanisms of differences in different research results, and provide a reference for comprehensive taste assessment, personalized oral care and future research design in geriatric dentistry.

2. Physiological changes in saliva of the elderly

Saliva can not only moisten the mouth and help form food masses but also dissolve the soluble substances in food and transport them to taste receptors. Therefore, the quantity, composition and physical properties of saliva may affect the transmission of taste stimulation. Although dry mouth is more common in the elderly, the decrease in saliva flow rate cannot be fully regarded as a direct result of natural ageing. Some salivary glands of the healthy elderly can still maintain a relatively stable secretion capacity, but the use of drugs, dehydration, chronic diseases and abnormal salivary gland function may have a more significant impact on the flow rate. Existing studies differ in the health status of subjects, saliva collection methods, and measurement of irritating or non-irritating saliva, which also makes it difficult to form a unified conclusion about the relationship between age and saliva flow rate [2].

In addition to the amount of secretion, ageing may also change the composition of ions, proteins and mucoproteins in saliva, as well as viscosity, lubricity and surface binding ability. Proteins and mucoproteins in saliva can participate in the protection of oral mucosa and affect the dissolution, diffusion and clearance of taste molecules. Too little saliva or too high viscosity may delay the arrival of the taste substance to the receptor, thus changing the intensity and duration of stimulation. The review of Xu et al. pointed out that age-related changes in saliva quality may be more helpful in explaining dry mouth and abnormal taste in the elderly than simple changes in flow rate [2].

The change of mucoprotein glycosylation provides a further mechanistic explanation for the relationship between saliva and taste. Pushpass et al. found that the glycosylation of salivary mucoprotein in the elderly and the binding ability to oral epithelial cells are reduced and may weaken the protective environment on the surface of the oral mucosa and its response to taste stimulation [3]. However, the study mainly adopts in vitro cell models, and the experimental environment cannot fully reproduce the saliva flow, food processing and neural response in the real oral cavity. Therefore, the results can explain the potential mechanism, but it is not enough to prove that mucoprotein changes can directly lead to loss of taste in all elderly people. In general, changes in taste in old age may be the result of the joint action of saliva flow rate, ingredients and oral environment, rather than a single physiological indicator.

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3. Differences between the two main taste assessment methods

3.1 Principle and clinical application of solution-based taste test

Solution-based taste tests usually make different concentrations of taste substances containing sweet, sour, salty, bitter and other taste substances, which are given to the subjects by dripping, spraying or gargling, and determining the taste threshold according to whether they can detect or correctly identify the taste. This method can regulate the concentration and volume of stimulants, which is suitable for measuring the sensitivity of subjects to specific flavors. The drip test can also limit the stimulation to a specific area of the tongue, to observe the local taste function. By comparing the repeated measurement performance of the taste test, Fjaeldstad and others pointed out that the test tool should not only be clinically operable but also have sufficient sensitivity and reliability. The taste drop test proposed by it can provide more detailed taste sensitivity information than conventional screening [4]. However, liquid stimulation is easy to spread in the mouth, and the results may be affected by saliva dilution, swallowing behavior, solution volume and stimulation duration. For the elderly with dry mouth or difficulty swallowing, the same concentration of solution may also produce different perceived intensity.

3.2 Principle and clinical application of taste test paper test

The taste test paper test uses filter strips impregnated with different concentrations of taste substances. After placing it on the tongue, the subject is required to identify the taste. The test scheme established by Mueller et al. sets four types of stimuli and multiple concentration levels, namely sweet, sour, salty and bitter, so that the taste function can be quantified through unified scores [5]. Compared with the solution method, the taste test paper is easy to store and operate, requires less stimulation, and can also detect the local functions on both sides of the tongue, so it is suitable for clinical screening and repeated measurements. However, the substances in the test paper must be dissolved in saliva to effectively stimulate the taste receptor. Insufficient saliva flow rate, different degrees of tongue moisture or deviation of the position of the test paper may reduce the release of flavor, thus affecting the test score. In addition, the attention, understanding ability and familiarity with the name of the taste of the elderly may also affect the identification results, so a lower score does not necessarily mean that the peripheral taste function is impaired.

3.3 Evidence of inconsistent test results in existing studies

Although the solution test and the taste test paper test are both used to evaluate taste function, the two are not completely equivalent. Jung et al. studied 100 elderly people aged 65 and above. At the same time, they used the solution method and the taste test paper method to measure five flavors, and evaluated the dental condition, the use of dentures, saliva secretion and swallowing function. The study found that the total score of the two tests had a moderate correlation, but the degree of consistency under different oral functions and different tastes was not the same [6]. This shows that the two methods may measure different aspects of taste function: the solution method forms a wide range of liquid stimulation, while the test paper method provides more local and fixed stimulation. Insufficient saliva may significantly affect the release of taste substances in the test paper, but it does not necessarily affect the pre-dissolved taste solution to the same extent. At the same time, differences in stimulus concentration, scoring criteria and subject characteristics will also reduce the comparability between different studies. Therefore, it is not possible to directly judge whether the

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elderly have a general loss of taste according to the results of a single tool. By combining the two methods and recording saliva and oral functions at the same time, a more comprehensive and easier-to-explain assessment results may be obtained.

4. Critical analysis of mixed factors

4.1 Dental condition, use of dentures and swallowing function

The taste test results of the elderly may be affected by the joint effect of dental and oral function. Missing teeth will change the efficiency of chewing and the degree of food crushing, causing changes in the process of releasing taste substances and contact with saliva. Although dentures can restore part of the chewing function, dentures covering the hard palate may change the oral sense of touch, food temperature perception and eating experience. Yoshinaka et al.'s research on the elderly in the community found that dissatisfaction with taste is related to dry mouth when eating, unsatisfactory chewing and dentures covering the entire hard palate [7]. This result shows that the "lightening of taste" reported by the subjects may reflect the experience of taste, touch and chewing at the same time, and not necessarily just a decrease in sensitivity to taste receptors.

The swallowing function also affects the retention and diffusion of taste stimulation in the mouth. Hyposaliphary function may reduce the formation and lubrication ability of food mass, accompanied by difficulty in chewing and swallowing. The systematic review of Muñoz-González et al. shows that low salivary function is associated with objective chewing ability, swallowing ability and decreased taste perception [8]. Therefore, if the study does not record the number of remaining teeth, denture types and swallowing conditions, it is difficult to judge whether the test difference comes from the taste system or the influence of food processing and oral motor function.

4.2 Individual differences in the oral environment

The oral environment of the elderly has obvious individual differences, including saliva flow rate, oral mucosal moisture, drug use, chronic diseases, oral hygiene and eating habits. Dry mouth is a subjective feeling, while hyposalia is an objective state determined by flow rate measurement, and the two do not always exist at the same time. Yoshinaka and others found that subjective taste dissatisfaction is related to some oral factors, but the objective test results of each basic taste quality are not completely consistent with taste satisfaction [7]. This shows that the patient's evaluation of taste may also be affected by the comfort of eating and the overall feeling of the mouth.

Drugs and diseases may also change salivation, neurological function and cognitive state at the same time. If the elderly who take multiple drugs or suffer from chronic diseases are directly compared with healthy young people, the observed differences may be mistakenly attributed to age. In addition, the solution method is not the same as the taste test paper method in terms of dependence on salivary conditions. Research by Jung et al. shows that oral and functional characteristics affect the results of the two tests in different ways [6]. Therefore, clinical research should record medication, disease, dry mouth, cognition and oral hygiene, and control these variables in the analysis.

4.3 Limitations of in vitro research and observational clinical research

In vitro research can control experimental conditions and explore the potential mechanism of saliva composition affecting taste, but it cannot fully simulate saliva flow, chewing, swallowing,

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temperature change and neural feedback during real eating. Therefore, the changes in mucoprotein found in the cell model cannot be directly equivalent to the clinical loss of taste in the elderly. Although observational clinical research is closer to the real environment, it is easily affected by sample selection, measurement standards and uncontrolled confounding factors.

The relevant studies included by Muñoz-González and others are all cross-sectional studies, and the definitions and measurement methods of hyposaliva in different studies are not consistent [8]. Cross-sectional data can only show that there is a correlation between factors, and it is impossible to confirm whether saliva changes precede and lead to loss of taste. At the same time, the samples of elderly studies often include participants with different health conditions, living environments and medication backgrounds, which limits the direct comparison between studies. Future research should adopt a unified saliva and taste test procedure to expand the representativeness of the sample and observe changes in individuals with age through vertical design, to more reliably distinguish the impact of natural ageing, disease, drugs and oral function.

5. Clinical significance and future research direction

The taste assessment of the elderly should not rely only on single test scores. Clinical personnel should first understand the subjective taste changes of the patient and make a comprehensive judgement in combination with the solution test, taste test paper test, saliva flow rate, oral moisture, the number of remaining teeth, denture type, swallowing function, disease and medication. The functions reflected by the two taste tests are not the same, and the combined use helps to distinguish between extensive and local taste abnormalities. The evaluation results should also be combined with the patient's dietary changes and nutritional risk interpretation and avoid simply attributing all abnormalities to age.

Interventions for salivary function need to be formulated according to the specific causes of dry mouth and hyposaliva. A systematic review of Gil-Montoya et al. shows that existing interventions include drug-induced salivary stimulation, oral mucosal lubrication, local treatment and non-drug measures, but the effects of different treatments are not consistent [9]. Some drugs are mainly suitable for salivary disfunction after radiotherapy or dry syndrome-related and cannot be directly extended to all elderly people. Although oral lubrication can alleviate symptoms, its effect is usually short-lived. Therefore, before treatment, it should be judged whether the patient has objective salivation deficiency, and drug side effects and individual tolerance should be evaluated.

The management of taste disorders can also include improving oral hygiene, treating related oral diseases and providing personalized dietary guidance. Braud and Boucher pointed out that improving oral hygiene may promote taste ability, and measures such as zinc supplementation may be effective in some specific patients, but the quality of evidence for different interventions varies greatly [10]. Therefore, it is not appropriate to use a single supplement as a universal treatment plan. Future research should establish unified saliva collection and taste assessment standards, carry out multi-center, large-sample and longitudinal research, and combine objective test results with dietary intake, nutritional status and quality of life. By identifying the saliva, oral and whole-body health characteristics of each elderly person, more targeted oral care and taste management programs can be gradually formed.

6. Conclusion

This article critically analyses the physiological changes of saliva in the elderly, the differences between the solution-based taste test and the taste test paper test, and the oral and methodological

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factors that may affect the taste assessment results. Based on the existing evidence, the changes in the taste of the elderly cannot be simply regarded as the inevitable result of natural ageing. The characteristics of saliva flow rate and composition, teeth and denture condition, swallowing function, disease, drug use and test tools may together cause differences in the study results. The solution method and the taste test paper method have their own advantages and limitations, and it is difficult for a single test to fully reflect the actual taste function of the elderly.

The limitation of this article is that it is mainly based on the existing literature for analysis, without original experiments or long-term follow-up, and there are large differences in the relevant research in terms of sample characteristics, saliva measurement and taste test standards. Therefore, it is still difficult to determine the direct causal relationship between saliva changes and loss of taste. Future research should unify the evaluation procedures, adopt more representative large samples and longitudinal designs, and strengthen the control of mixed factors such as diseases, drugs and oral function. Clinical practice should be combined with a variety of taste tests, saliva tests and individual oral conditions to provide more accurate assessment and personalized care for the elderly.

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