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Evaluation of different taste sensations along with body mass index (BMI) in geriatric patients with and without complete dentures

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Abstract:

BACKGROUND: The purpose of this study was to investigate the effect of acrylic full removable dentures on the perception of four primary tastes (sweet, sour, salty, and bitter), as well as to determine if there is a correlation between changes in body mass index (BMI) and taste perception.

MATERIALS AND METHODS: A total of 60 patients who wore acrylic removable dentures and 60 controls were included in the study as a convenient sample. Sixteen solutions for basic tastes were prepared, and the patients were asked to identify the taste of each solution from the lowest concentration. Anthropometric measures, such as height and weight, were measured and recorded in an MS-Excel sheet. The data were analyzed using SPSS version 23.

RESULTS: The results showed that patients with complete removable dentures had lower taste scores for sourness ($P < 0.001$) and sweetness ($P < 0.001$) compared to the control group. However, there was no significant difference in salt taste scores ($P = 0.218$) and bitterness ($P = 0.002$) between the two groups. Additionally, the study found a correlation between lower BMI values and higher taste scores among denture-wearing patients, indicating an inverse relationship between total taste scores and BMI.

CONCLUSIONS: The study suggests that geriatric patients with complete dentures have reduced taste sensations compared to those without dentures which can have a negative impact on their nutritional status. Therefore, it is crucial to provide adequate nutritional support and dietary counseling for geriatric patients based on health policy to maintain their overall health and well-being.

Keywords:

Aging, BMI, complete dentures, geriatric dentistry, taste buds, taste perception

Introduction

As we age, our ability to taste and identify different flavors may decline due to changes in the taste buds and oral cavity. This can affect our dietary intake and lead to malnutrition, which is a significant concern for the geriatric population.[1]

The sense of taste is a complex process that involves the integration of gustatory, olfactory, and trigeminal perceptions. Gustatory sensation is particularly important as it helps us to identify nutritious foods and reject unpalatable ones by responding to sweet, salty, sour, and bitter stimuli. Taste perception is mediated by taste buds, which contain four types of cells that are differentiated based on their morphology, protein expression, and signaling pathways. Neurotransmitters activate the taste receptors, which then stimulate afferent sensory fibers. However, it is still unclear how the brain distinguishes

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between different stimuli and produce distinct taste perceptions.[2]

Taste receptors are not confined to the tongue alone; they can also be found on the palate, pharynx, epiglottis, uvula, and the beginning of the esophagus. An adult typically has approximately 10,000 buds on their tongue, 2,500 on the soft palate, over 900 on the epiglottis, more than 600 on the pharynx and larynx, and about 250 on the oropharynx. The impact of taste on food consumption is dependent on how noticeable the sweet, salt, sour, or bitter components are in foods and beverages, as well as the relative importance of sensory factors compared to other factors such as health and convenience in a person's dietary choices. Taste perception can be influenced by various factors, including age, alcohol consumption, dentures, smoking, medications, illegal drugs, surgical procedures, systemic and neurological disorders, and viral infections, among others.[3] However, removable dentures are the primary factor that affects taste sensation as they seal off the palatal region, making it difficult for individuals to detect the presence, temperature, and taste of food.[2]

Complete dentures, a common form of tooth replacement in the elderly, can also affect taste sensations by altering the oral cavity's physical environment. Thus, it is important to evaluate the relationship between complete dentures, taste sensations, and body mass index (BMI) in geriatric patients to better understand the impact of these factors on their nutritional status. In this study, we aim to assess the taste sensations of geriatric patients with and without complete dentures and determine if there is a correlation between taste sensations and BMI. The findings of this study can support the idea that complete upper dentures made of acrylic material can impair a patient's sense of taste and subsequently affect their BMI. Therefore, it is crucial for medical professionals, including dentists and doctors, to be aware of the possibility of taste disorders and provide necessary guidance and treatment. It also improves the dietary management of elderly patients with compromised taste sensations and ensure their overall health and well-being.

Material and Methods

Study design and setting

This is a case-control study conducted over a period of 2 to 3 months in the department of oral and maxillofacial prosthodontics.

Study participants and sampling

Sixty completely edentulous patients who had been wearing complete dentures for at least 6 months were selected as the case group, whereas sixty patients with natural teeth were selected as the control group as a convenient sample. Both male and female individuals aged 60 years and above were included in the study, based on the defined inclusion criteria. Exclusion criteria were non-smokers or non-tobacco chewers, non-alcoholic individuals, and those who had not taken any medication known to alter taste function in the previous 6 months. Persons with a recent history of oral diseases, such as xerostomia, hypo-salivation, tongue coating, atrophic glossitis, or ear, nose, and throat infections, as well as other non-communicable diseases, were not included in the study.

Ethical consideration

Ethical approval was obtained from the Institutional Scientific Ethical Board under research protocol number: JSSDCH/IEC/68-2022, India and all participants provided their informed consent.

Data collection tool and technique

All participants underwent a clinical examination to gather information on their general health, oral habits, systemic health, drug use, oral diseases, surgeries, and history of denture use. Prior to the examination, patients were instructed to rinse their mouth thoroughly. A comprehensive clinical examination was performed using a No. 23 explorer and mouth mirror under natural light to exclude any pathologies. Taste perception will be assessed using a tool standardized by Neelima Gupta for basic tastes, with taste strips containing the following concentrations and compounds[4]:

Sweet: 0.4, 0.2, 0.1, and 0.05 g/ml sucrose;

Sour: 0.3, 0.165, 0.09, and 0.05 g/ml citric acid;

Salt: 0.25, 0.1, 0.04, and 0.016 g/ml sodium chloride; and

Bitter: 0.006, 0.0024, 0.0009, and 0.0004 g/ml quinine hydrochloride.

The taste strips were filter paper strips with a length of 8 cm and a tip area of 2 cm. They were dipped in the respective solutions of the four basic tastes and placed on the dorsal surface of the anterior part of the tongue. Taste scores were estimated for each concentration of all four basic tastants. A score of 1 was given for correct identification, and the maximum score of 16 was awarded for the identification of all the taste strips.

Anthropometric measures such as height and weight were measured with patients barefoot and wearing light clothes. The BMI of both the case and control groups was calculated using a person's weight in kilograms divided by the square of their height in meters (kg/m^2). The Asia-Pacific BMI classifications were used to determine

the standard weight status categories associated with BMI ranges for adults.[5]

Statistical methods

The data obtained from the study subjects will be entered into the excel sheet and data analysis will be performed using SPSS software version 22.0. Descriptive statistics like mean and standard deviation will be calculated. The intensity of taste for each basic tastants is expressed in scores. Taste scores for basic tastes were compared in between patients with complete dentures and without complete dentures by using independent sample *t*-test. Chi-square test was applied to find the association of altered taste and BMI with respect to the same. A *P*-value <0.05 will be considered as statistically significant.

Results

There were 120 participants who took part in the study in which 60 participants with denture (case group) and 60 participants without denture (control group). One hundred twenty participants altogether showed that 59% were males and 41% were females with mean age 63.2 ± 8.3 years. There were 37.7% were literates and 62.3% were illiterates. Moreover, 82% of the population was married, whereas the remaining 18% were unmarried. There were 60.6% participants did not have any habits, whereas 27.8% had a smoking habit, 6.6% had a habit of consuming smokeless tobacco, and 5% had both smoking and smokeless tobacco consumption habits. Similarly, it was observed that 62.2% of the participants did not have any other co-existing medical conditions, whereas 11.4% had diabetes, 7.2% had hypertension, and the remaining 7.2% had both diabetes and hypertension. 19.7% experienced xerostomia, whereas the remaining 80.3% did not have xerostomia as shown in Table 1.

Out of the 120 total population, the mean BMI was 16.9 ± 1.1, mean sour taste score was 2.8 ± 1.1, mean sweet taste score was 2.5 ± 1.1, mean salt taste score was 1.3 ± 0.6, mean bitter taste score was 3.1 ± 1.1, and total taste score was 9.8 ± 2.7 as observed in the case group and the mean BMI was 21.3 ± 2.3, mean sour taste score was 2.3 ± 0.9, mean sweet taste score was 2.3 ± 1, mean salt taste score was 1.1 ± 0.4, mean bitter taste score was 2.8 ± 1.1, and total taste score was 8.6 ± 2.3 as observed in the control group as shown in Table 2. When the taste score was compared between the cases and controls using independent *t* test, it was seen that there was a significant statistical difference between the sour taste scores ($P < 0.001$), sweet taste scores (<0.001), and total taste score ($P < 0.001$) but not bitter taste score ($P = 0.002$) and salt taste score ($P = 0.218$). Similarly, BMI between cases and controls using independent *t* test, there was a significant statistical difference seen between the two groups ($P < 0.001$).

Table 1: Demographic data of the participants

Characteristics	Demographic data
Total participants-120	Case (60)
	Control (60)
Males	59% were
Females	41% were
Mean age	63.2±8.3 years
Literates	37.7%
Illiterates.	62.3%
Married	82%
Unmarried	18%
No habits,	60.6%
Smoking	27.8%
Smokeless tobacco	6.6%
Both smoking and smokeless tobacco consumption habits	5%
No comorbidities	62.2%
Diabetes,	11.4%
Hypertension	7.2%
Both	7.2%
Xerostomia	19.7%
No xerostomia	80.3%

Table 2: Difference in the taste scores and BMI between cases (with dentures) and controls (without dentures)

Taste score	Cases (*n*=60) Mean±SD	Controls (*n*=60) Mean±SD	*t*	*P*
Sour	2.8±1.1	2.3±0.9	5	<0.001*
Sweet	2.5±1.1	2.3±1	1.2	<0.001*
Salt	1.3±0.6	1.1±0.4	4.5	0.218
Bitter	3.1±1.1	2.8±1.1	3.2	0.002*
Total score	9.8±2.7	8.6±2.3	5.2	<0.001*
BMI	16.9±1.1	21.3±2.3	-12.8	<0.001*

*Significant *P*

When Pearson correlation was used, it was observed that there was a noteworthy inverse correlation between BMI and all taste scores in the case group being studied. This implies that as the BMI value increases, the taste scores among that group decrease. The most substantial correlation was found between BMI and the overall taste score, which was -0.730 as shown in Table 3.

Similarly, it was observed that there exists a significant correlation between BMI and taste scores, specifically for sweet, bitter, and overall scores. However, there was no significant correlation found between BMI and sour and salt taste. When looking at the control group, the highest strength of correlation was found between BMI and total taste score, with a value of -0.744 as shown in Table 4.

Discussion

Poor oral health and tooth loss can have negative effects on food intake, leading to poor nutrition. Taste plays a vital role in assessing the nutritional value of food,

Table 3: Correlation between the BMI and taste scores among cases (Denture wearers)

Variable	Correlation co-efficient	*P*
Sour	-0.536	<0.001*
Sweet	-0.443	<0.001*
Salt	-0.381	0.002*
Bitter	-0.569	<0.001*
Total score	-0.730	<0.001*

*Significant *P*

Table 4: Correlation between the BMI and taste scores among controls (Non-denture wearers)

Variable	Correlation co-efficient	*P*
Sour	-0.487	0.05
Sweet	-0.521	0.003*
Salt	-0.51	0.786
Bitter	-0.648	<0.001*
Total score	-0.744	<0.001*

*Significant *P*

aiding in oral ingestion, and preventing the ingestion of potentially harmful substances. It is commonly associated with the pleasure of eating and is influenced by various factors such as texture, temperature, and odor.[2,4] According to clinical reports, the presence of removable dentures that cover the palate can disrupt normal oral functions, including smell and taste perception.[6]

In 2003, Mueller *et al*. developed a method to evaluate taste perception, which involves using filter paper strips dipped in solutions containing the four basic tastes (salty, sweet, bitter, and sour). These strips are randomly placed on the center of the tongue, and the patient can close their mouth to identify the taste solution that spreads along the tongue and mouth.[7] Similarly, Neelima Gupta suggested a similar taste evaluation technique. Therefore, we used the same technique to assess the four types of taste sensation in geriatric patients with dentures (case group) and those with normal dentition (control group).

The results of the current study indicate that taste scores were significantly lower in the control group compared to the case group, indicating a decrease in taste perception in individuals with dentures. These findings are consistent with the findings of Strain,[8] Henkin and Christiansen,[9] and Shimoyama and Sato[10] who both demonstrated a decrease in taste sensitivity after the placement of dentures. Similarly, Tanaka investigated the influence of palatal coverage on oral functions and found impaired perception of taste.[11] However, in contrast to our study, Strain did not observe any significant changes in taste acuity or oral sensation in individuals with dentures.[11] Additionally, Tahereh Ghaffari *et al*.[6] reported that denture wearing does not affect gustatory and olfactory senses.

The current study demonstrated a significant reduction in sour and sweet taste perception among denture wearers compared to the control group. However, no significant changes were observed in bitter and salty taste perception between the two groups. Juzikis also reported that patients with full upper removable dentures perceived sweet and sour tastes as weaker than those without dentures, and the same trend was observed for bitter and salty tastes.[1] In contrast to our study, Kapur reported that complete artificial dentition may improve taste discrimination and recognition for sweet and sour solutions.[12] He also suggested that the loss of natural dentition may lead to dysgeusia, rather than artificial dentition promoting increased gustatory sensitivity.[13] Recent studies have suggested that abnormalities in the hard or soft palate can significantly elevate thresholds for sour and bitter substances, whereas salt and sweet substances remain unaffected. These studies indicate that the palate may play a role in sour and bitter taste perception, and patients with maxillary dentures that cover and closely adapt to the palatal region may face difficulty in tasting bitter and sour.[9,13,14]

The current study found a significant difference in BMI between the case and control groups. This is consistent with the findings of Moynihan PJ *et al*.,[14] who suggested that edentulous and partially dentate patients may be at a higher risk of poor health due to impaired masticatory ability, which can negatively affect food choice, nutrient intake, and overall nutritional status, potentially leading to health issues. da Silva ROC *et al*. also explained that the taste disturbances can also impact an individual's nutritional status.[2] As a result, dentists should consider the nutritional risk for patients with compromised dentition and understand the potential consequences for their health and well-being.[14]

The present study found a significant negative correlation between BMI and taste perception scores in the denture wearer group. This is consistent with the findings of Juzikis who reported that acrylic full upper removable dentures can weaken taste perception in patients.[1] da Silva ROC *et al*.[2] also observed that dentures that cover most of the hard palate can affect taste perception, which can have a significant impact on quality of life and may represent an underlying disease that is often overlooked by healthcare professionals. Additionally, Ghaffari explained that the number of taste buds decreases with age, resulting in an increase in gustatory threshold level.[6] However, Boucher CO *et al*.[15] propose that wearing complete dentures may alter the texture of food, which can be misinterpreted as a taste alteration. One possible cause of this problem could be the over-polished palatal surface of the maxillary denture.

Research on the sensory function of denture wearers has been limited. Inserting a complete maxillary denture has been found to frequently reduce taste perception. This may be due to covering the palate, which inhibits olfaction. Additionally, upper removable dentures may affect taste and smell by disrupting the natural airflow between the oral and nasal cavities. This airflow is crucial for identifying retro-nasal flavor stimuli during mastication, and the upper removable denture prevents regular contact between the palatal receptor sites and taste samples.[6] The use of prostheses can alter food perception by modifying taste and other forms of oral perception. Full denture users often report a loss of taste ability. Covering the palate may only be part of the physical effect of the prosthetic apparatus that stimulates oral somatic afferent nerves, which can interfere with the transmission of the taste message to the brain.[2]

Limitation and recommendation

The study has certain limitations that need to be acknowledged. There is a possibility of expanding the study to include additional factors that may influence taste perception, such as saliva flow, olfactory sensitivity, chronic diseases, harmful habits, prosthesis properties (e.g., material thickness, surface smoothness, volume, and construction), previous dentures, lifestyle habits, and oral hygiene practices. Additionally, since taste and smell disorders often occur simultaneously, evaluating that each chemosensory modality separately is essential. Furthermore, future research should focus on bite force and masticatory efficiency to improve prosthetic treatment and enhance the quality of life for these patients.

Conclusions

The findings of this study support the idea that complete upper dentures made of acrylic material can impair a patient's sense of taste and subsequently affect their BMI. Therefore, it is crucial for medical professionals, including dentists and doctors, to be aware of the possibility of taste disorders and provide necessary guidance and treatment based on the health policy.

We would like to conclude that teeth replaced by dentures that cover the palate can interfere in the sense of taste and in the physical perception of food due to the obliteration of taste papillae and the mechanoreceptors present on the palate. Another important factor to consider is the reduced number of tastes buds with the process of aging, promoting an increase in the taste perception threshold. Modifications in the sense of taste, reduction in mucosa lubrication, and difficulties in swallowing can result in changes in alimentary habits, and the affected patients show lower in their nutritional status.

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Conflicts of interest

There are no conflicts of interest.

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