Original Article

Assessment and Evaluation of Gustatory Functions in Patients with Diabetes Mellitus Type II: A study

Shriya Khera, Anjali Saigal[1]

Department of Oral Medicine and Radiology, Maulana Azad Institute of Dental Sciences, New Delhi, [1]Oral Medicine and Radiology, Thapar Hospital and Research Institute, Moga, Punjab, India

Abstract

Introduction: The assessment of taste is critically important for an individual to enjoy life. This however, gets altered in various diseases. Diabetes Mellitus is one of the diseases in which person has dysgeusia. **Objectives:** This study was done to assess different taste sensations in patients suffering from Diabetes Mellitus Type II. **Methods:** A total of 120 subjects were taken in this study and were divided into 3 groups. One group consisted of patients who were uncontrolled diabetics ($n = 40$), the second group of controlled diabetics ($n = 40$) and 40 subjects who were normal healthy individuals (control group). To assess their gustatory functions, two tests were performed, whole mouth above threshold and localized taste test. Whole mouth above threshold test was performed by assessing their detection threshold for each taste. **Results:** It was seen that patients with Diabetes Mellitus showed a high threshold to sweet, salty and sour taste. Bitter was not affected in either of the groups. The other test performed was localized (spatial) test. In this test, various parts of the oral cavity are assessed by dabbing the highest concentration of the prepared solutions and their response is noted. The tongue was divided into Left posterior tongue (LPT), Right posterior tongue (RPT), Right Anterior tongue (RAT), Left Anterior tongue (LAT). Soft palate was divided into Right Soft Palate (RSP) and Left Soft Palate (LSP). The results showed a significant difference for the sweet taste in the localized regions (right anterior tongue [RAT], left anterior tongue [LAT], right posterior tongue [RPT], left posterior tongue [LPT], right soft palate [RSP], and left soft palate [LSP]) of the mouth between the three groups ($P < 0.05$). The results of the salty taste showed significant differences in the RAT, LAT, RSP, and LSP regions of the mouth between the groups ($P < 0.05$). However, the regions of LPT and RPT showed no differences between the study groups ($P > 0.05$).The results showed a significant difference in the sour taste in the localized regions of the mouth in all the study groups ($P < 0.05$). The results of the bitter taste showed significant differences in the regions of the mouth in all the three groups ($P < 0.05$). However, the region of LPT showed no differences between the study groups ($P > 0.05$). **Conclusion:** Within the limitation of this study, it was concluded that the diabetic patients had an increased satiation effect of sweet taste therefore they needed an increased quantity of sweet taste to be perceived. It was also significant for salty and sour taste, whereas bitter taste had no significance. Spatial taste test also showed differences in different regions of the tongue, soft palate. The left posterior tongue area showed no changes.

Keywords: Detection threshold, dysgeusia, gustatory function, Diabetes mellitus, spatial

Introduction

Human taste perception may be categorized into four well known and widely accepted descriptors, namely sweet, bitter, salty, and sour.[1,2] Taste disorders have been reported during the course of various diseases. Diabetic patients appear to be especially prone to taste disorders; these disorders have been described during the course of diabetes mellitus (DM). The common observation of this disorder is chronic hyperglycemia, resulting from either a defect in insulin secretion from the pancreas or resistance from the body's cells to insulin action or both.[3] In newly diagnosed untreated diabetic patients, their preference for sweet drinks to quench their thirst is seen. Dysgeusia is also commonly seen in DM Type 1 and Type 2 patients with a significant and somewhat specific impairment in sweet taste detection.[4,5] Chemical gustometric score (CGS) has been frequently used to screen diabetic patients for taste disorders and is usually based on a threshold for each of the four primary tastes. CGS is a global evaluation of taste based on all four primary tastes.

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Address for correspondence: Dr. Anjali Saigal, Thapar Hospital and Research Institute, Moga, Punjab, India. E-mail: skhaira1988@gmail.com

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The present study was planned to evaluate the gustatory function appreciation in patients with DM Type II and to compare the intensities among four basic tastes in these patients. A regional taste examination was also carried out to evaluate the gustatory function in six different locations of the oral cavity in the same patients and correlations and comparisons among them, along with considerations to age and gender of the participants who participated in the study.

The aim and objective of this study was to assess the gustatory function in patients with DM, to compare their results with normal healthy individuals. This was done by performing whole-mouth test and spatial (localized) taste test.

Materials and Methods

The present study was conducted in the Department of Oral Medicine and Radiology, Dasmesh Institute of Research and Dental Sciences, Faridkot (Punjab), on 120 participants after the ethical clearance was obtained. The age range of these participants was from 24 to 73 years. These 120 participants were divided into two groups, Group A having individual with DM Type II and Group B who were nondiabetics (normal healthy individuals). Group A was further divided into two categories: controlled diabetics and uncontrolled diabetics based on the HbA1c values. It was made sure that the patients did not have any neuropathies and the patients had normal salivary gland functioning. No patients having any other medical illness except for DM were included in the study.

The various taste solutions were prepared to assess the whole mouth threshold with varying concentrations to grade the intensity. The various concentrations for sweet taste made from sucrose were (0.01-1.00 mol/L), NaCl for salty taste (0.01-1.00 mol/L), citric acid for sour taste (0.032-0.320 mol/L), quinine hydrochloride for bitter taste (0.01-1.00 mol/L). Blood tests were performed including hemoglobin, random blood sugar level, Glycated hemoglobin (HbA1c). Hence, three groups were formed of total 120 patients: Group I consisted of uncontrolled diabetics (HbA1c >7%), Group II consisted of controlled diabetics (HbA1c – up to 7%), and Group III consisted of normal healthy individuals (HbA1c <5.6%).

Procedure for gustatory function evaluation

For testing gustatory functions, two different tests were administered: a whole-mouth, above-threshold test and spatial (localized) taste test.

Whole-mouth, above-threshold test

The patient was asked to rinse the mouth thoroughly with distilled water, followed by presenting with three rows of cups which were randomly arranged on a tray. One of the cup contained 5 ml of the sample solution while the remaining two had 5 ml of distilled water. The subjects were given one cup of 5 ml solution at a time and were asked to sip, swish for 15 seconds and spit out the sample. If the patient was unable to identify, a higher concentration was given and the same procedure was done. In between of presenting the samples, water was given to remove the residual taste. Then, he was asked to identify correctly the quality of the taste (namely, sweet, salty, sour, bitter, and tasteless) and it was recorded. If the participant failed to identify the correct solution, a solution with a next higher concentration was presented. Once an accurate selection was made, the procedure was repeated at the same concentration until three consecutive correct responses were obtained and it was the recorded as detection threshold and was scored. The scores were given as "1" for the lowest concentration and "5" for the highest concentration.

Spatial (localized) taste test

In this test, the ability of the participants to identify different tastes in various localized areas of the mouth was evaluated. The six different locations were right and left anterior and posterior lateral surface of tongue and the two sides of soft palate, lateral to the midline. This test consisted of applying each taste stimulus of highest concentration and distilled water (blank) in these areas for 5 s. It was ensured that the areas of application of the tastant and distilled water were at least 2 cm away from each other. The response of the participant was given a score on the intensity scale ranging from 0 for no taste to 9 for very strong taste.

Results

For all 120 patients, age range was from 24 to 73 years with a mean of 46.31 (±10.957 standard deviation [SD]) years. In all the three groups, there were 60 males and 60 females. The values of hemoglobin % ranged from 9.0 to 14.8 gm% with a mean of 12.617 (±1.35 SD). The random blood glucose levels showed a gradual decrease in the random blood glucose values from Group I to Group III. The glycosylated hemoglobin values showed a decrease in the values of HbA1c from Group I to Group III.

The results of the whole-mouth, above-threshold taste test of the sweet taste suggested that there is a trend toward decreased sensitivity for sweet taste from Group III to Group II to Group I ($P < 0.01$). For the sweet taste, 16 participants in Group I and one participant in Group II showed hypogeusia, whereas no participant with hypogeusia was seen in Group III. The salty taste was assessed and it was seen that the mean value was the highest in Group III followed by Group II and lowest in Group I which showed gradual decrease in the sensitivity of the taste buds to salty taste ($P < 0.01$). For salty taste, seven participants had hypogeusia in Group I and none of the participants in the other two groups showed hypogeusia. The score for the sour taste was highest in Group III as compared to Group II and least in Group I which shows a gradual decrease in the sensitivity of the taste buds to sour taste ($P < 0.01$). In Group I, six participants showed hypogeusia to sour taste whereas no participant showed hypogeusia in Group II and III. There was no significant difference for the bitter taste in all the three groups ($P > 0.05$).

The localized taste test was done to assess the intensity of each tastant, and it was rated on an intensity scale. The

results showed a significant difference for the sweet taste in the localized regions (right anterior temporal [RAT], left anterior temporal [LAT], right posterior tongue [RPT], left posterior tongue [LPT], right soft palate [RSP], and left soft palate [LSP]) of the mouth between the three groups ($P < 0.05$). The results of the salty taste showed significant differences in the RAT, LAT, RSP, and LSP regions of the mouth between the groups ($P < 0.05$). However, the regions of LPT and RPT showed no differences between the study groups ($P > 0.05$). The results showed a significant difference in the sour taste in the localized regions of the mouth in all the study groups ($P < 0.05$). The results of the bitter taste showed significant differences in the regions of the mouth in all the three groups ($P < 0.05$). However, the region of LPT showed no differences between the study groups ($P > 0.05$).

Discussion

CGS has been frequently used to screen diabetic patients for taste disorders.[6] In the present study, Group I showed decreased detection threshold for sweet, salty, and sour taste. In Group II, the participants responded to the lower concentrations of the taste solutions (sweet, salty, and sour) when concentrations to Group I and Group III, the participants responded to lowest concentrations of the taste solutions which implies that was perceived in lower concentrations in all the three groups. A study conducted by Gondivkar *et al.*[7] showed results which were in agreement to our study. Khobragade *et al.*[8] observed that all the four tastes were affected in patients with DM Type I as compared to normal healthy individuals. Shanaz Mohammad and Raz[9] claimed that only sweet and salty taste got affected in patients with DM Type II as compared to normal healthy individuals. Lawson *et al.*[10] concluded in their study that only sweet gets affected in patients with DM Type II. Sixteen participants from Group I and one participant from Group II had hypogeusia to sweet taste. No such results were seen in Group III. Hypogeusia to salty taste was seen in seven participants from Group I; none showed such response from Group II and III. As regards to sour taste, six participants showed hypogeusia in Group I and no such response was seen in Group II and III. No hypogeusia to bitter taste was seen in any groups, and no subject showed ageusia.

This result is contrary to the study conducted by Shailesh and Amol (2004)[11] in which six participants showed ageusia to sweet taste. The reason for this difference could be that in our study, participants with only DM Type II were taken who were not on any other medications, suggesting that diabetes alone may not be possible for causing ageusia. Schelling *et al.* suggested that taste alterations in diabetics result from sensory neuropathy or a nonspecific "satiation effect" due to persistently elevated blood sugar concentrations. Because of decreased taste sensitivity to glucose, it could result in an increased amount of sugar to be ingested to produce a desired effect.[12]

Hanig (1901) demonstrated regions of maximum sensitivity to sweet, sour, salty, and bitter compounds located in separate areas of the tongue.[13] In the present study, we also evaluated sensitivity to localized areas of the mouth. The three groups showed significant changes in the values of intensity to sweet taste in the RAT, RPT, LAT, LPT, RSP, and LSP ($P < 0.05$). The response to salty taste in the localized regions of the mouth also showed significant values ($P < 0.05$) except for the regions in RPT and LPT ($P > 0.05$). The scores of the sour taste showed significant results in all the three groups ($P < 0.05$). The response of bitter taste in the localized areas was significantly altered between the three groups ($P < 0.05$) except for the response in the LPT. Gondivkar *et al.* (2009) concluded that all the tastes in the different regions of the mouth were significantly altered except for the salty taste in the RPT and LPT area.

Results of the present study showed that there was an impairment of sweet, salty, and sour taste between the diabetic participants when compared with normal healthy individuals in whole-mouth, above-threshold test. The localized test showed that all the tastes, except for salty in the area of RPT and LPT and bitter in the area of LPT, showed significant differences.

Dental practitioners are often the first clinicians to be presented with complaints about changes in taste.[14] Considering the scanty literature and contradictory results on comprehensive study of altered gustatory functions in patients with DM, this study was an attempt in the direction to provide useful information to the dental clinician.

The response to whole mouth, above threshold taste test showed that the response to sweet, salty and sour taste was attained at higher concentrations in Group I than Group II and least in Group III.The response to bitter taste in all the individuals were achieved at lower concentrations in all the three groups showing that it does not alter in diabetic patients. Hypogeusia was seen in 16 subjects in Group I (Uncontrolled diabetics) and 1 subject in Group II (Controlled diabetics) to sweet taste. Hypogeusia to salty taste was seen in 7 subjects of Group I whereas none in any other groups showed these results. Hypogeusia to sour and bitter taste was not seen in any of the groups. Localized taste test was done to assess the specific areas in response to taste. The results showed significant changes in the different areas of the tongue (RAT, RPT, LAT, LPT) and soft palate (RSP, LSP) for sweet and sour taste. No significant changes were seen in the RPT and LPT areas for salty taste and LPT for bitter taste were seen whereas other regions showed significant alterations.

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Conflicts of interest

There are no conflicts of interest.

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