

Burning Tongue and Taste Alteration in Xerostomic Undiagnosed Diabetic Patients with Vitamin D Deficiency

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Background: Silent diabetes and vitamin D deficiency are difficult to identify because the individual may not even realize they have one. Xerostomia-related burning tongue and taste changes may indicate a systemic condition such as diabetes or vitamin D deficiency.

Purpose: This case report analyzes the association between diabetes, vitamin D deficiencies, and xerostomia.

Case Presentation: A 44-year-old female patient complained of having a burning tongue and had lost taste for a week. Routine blood tests and assessments of the Oral Health Impact Profile-14 (OHIP-14) and Depression Anxiety Stress Scale-21 (DASS-21) showed normal results.

Case Management: Therapy consists of chlorine dioxide zinc-patented mouthwash, multivitamin, petroleum jelly, and oral hygiene instructions. The symptoms decreased significantly on the second visit, but taste perception did not improve. Another complaint was that the mouth felt dry. The results of the Summated Xerostomia Inventory-Indonesian Version (SXI-ID) and Clinical Oral Dryness Scoring System (CODS) examination showed the patient had mild xerostomia and the unstimulated salivary flow rate was lower than normal. Therapy consists of applying ethyl p-hydroxybenzoate gel, neurotropic vitamins, and blood tests for Hemoglobin A1c (HbA1c) and vitamin D 25 (OH) were advised for further evaluation would be more clear. The third visit showed there were no more complaints of dry mouth, and the taste perception was getting normal. The Unstimulated salivary flow rate and CODS were normal. The patient was diagnosed with diabetes and vitamin D deficiency based on the HbA1c examination results of 11% and vitamin D 25 (OH) of 12.5 ng/mL.

Conclusion: Xerostomia can indicate systemic conditions like diabetes and vitamin D deficiency. A comprehensive examination is carried out so the patient can receive optimal treatment.

Keywords: burning tongue, diabetes, taste changes, xerostomia, vitamin D deficiency

Introduction

Diabetes is a chronic disease characterized by increased levels of glucose in the blood, commonly known as hyperglycemia and glucose intolerance, due to the body not producing enough insulin or when the body cannot use the insulin produced effectively.¹⁻⁴ Diabetes is one of the most common non-communicable diseases in the world.⁵ The International Diabetes Federation released the Diabetes Atlas 2021, which estimates that 537 million adults (aged 20 to 79) globally, or 10.5% of the population, had diabetes. Of these, 240 million people—or more than half—are unaware they have the condition. Diabetes-related deaths among people under 60 account for 32.6% of reported mortality rates. An estimated 19.5 million adults in Indonesia suffer from diabetes, of which 73% remain undiagnosed. Additionally, diabetes has a mortality rate of 6%.³ Risk factors for diabetes include high uric acid levels, quality or quantity of sleep, smoking, depression, cardiovascular disease, dyslipidemia, hypertension, aging, ethnicity, family history of diabetes, a lack of physical activity, and obesity.² Signs and symptoms of diabetes can occur suddenly or take a long time for the

patient to realize. Symptoms of diabetes include frequent thirst, hunger, and urination; dry mouth; blurred vision; frequent fatigue; and weight loss.^{1,4}

Vitamin D is a fat-soluble vitamin that functions to maintain the homeostasis of calcium, phosphorus, etc.⁶ Vitamin D deficiency can be caused by insufficient nutritional intake of vitamin D, increased catabolism of vitamin D, inefficient production in the skin, or inadequate sun exposure.⁷ Vitamin D deficiency is also a non-communicable disease that has become a global pandemic, affecting 15.7% of the world's population. The prevalence of vitamin D deficiency in Indonesia ranges from 60 to 90% in several studies.^{6,8} Patients with vitamin D deficiency are usually clinically asymptomatic.^{6,9} Individuals with vitamin D deficiency also show a 48% reduction in insulin secretion compared to individuals with optimal vitamin D levels.¹⁰ This shows that vitamin D deficiency is related to diabetes, in line with the results of research by Gopika et al in India, which reported that vitamin D deficiency was found in 86 (74.14%) of 116 diabetes patients.⁹

Xerostomia is a subjective dry mouth condition that occurs due to insufficient salivary secretion or salivary gland dysfunction.^{5,11} Symptoms of xerostomia include dry mouth, a burning sensation in the oral cavity, decreased or changed taste, halitosis, and difficulty chewing food or speaking.¹¹ Xerostomia can be caused by many factors, including salivary gland disorders, the effects of therapy such as surgery, radiotherapy, and chemotherapy, pharmacological effects or side effects of drugs, nervous system disorders, viral infections, systemic diseases such as diabetes, and nutritional and hormonal deficiencies.^{5,11,12} The global prevalence of xerostomia is 22% of the population, with the prevalence of diabetes patients with xerostomia being 42.22%.^{11,13} This indicates that xerostomia affects almost half of the diabetic patients. Additionally, both diabetes and vitamin D deficiency may be correlated to the feeling of a burning tongue and a loss in or alteration in taste.^{14–16} The aim of this case report is to analyze the relationship between xerostomia-related taste alteration and burning tongue sensation in individuals with diabetes and vitamin D deficiency.

Case Report

A 44-year-old female patient came to the Department of Oral Medicine, FKG Unpad Dental and Oral Hospital, with complaints that her tongue felt sore, burning, and uncomfortable, especially on the left side, since 1 week ago. Complaints arise after eating spicy, sour, or hot foods, as well as when waking up early or not drinking enough fluids. The stinging and burning sensation disappeared when the patient consumes cold drinks or meals. Patients also complain that the taste of food becomes bland, resulting in a lack of appetite. The patient has no history of recurrent mouth ulcers or drug or food allergies. Her twice-daily routine of brushing her teeth—in the morning before breakfast and in the evening before bed—without using mouthwash or cleaning her tongue. She consumes 2 liters of mineral water per day and regularly consumes fruit and vegetables every day. The habit of smoking and consuming alcohol was denied. The patient admitted that she had no history of systemic disease and no family history of the same disease.

The general condition of the patient is moderately ill, with *compos mentis* consciousness. The vital signs examination was normal; the patient's height was 155 cm with a body weight of 68 kg. Extraoral examination showed a symmetrical face, dry and exfoliated lips but not painful (Figure 1), lymph nodes were not palpable and not painful, and examination of the temporo-mandibular joint showed clicking in the right region but not painful. An intraoral exam showed that the dorsal region of the tongue had a yellowish-white plaque that could be scraped off without leaving an erythema. The tongue also displayed a depapillation pattern, characterized by irregular, multiple, diffusely demarcated whitish elevations on the posterior third of the tongue's dorsal surface, but there were no complaints of pain (Figure 1). Several teeth showed superficial caries, and the edentulous regions were restored with dentures. The patient's oral hygiene was good, with an Oral Hygiene Index Simplified (OHI-s) score of 0.3 (Figure 1).

A psychological examination was carried out to look for risk factors for symptoms of depression, anxiety, and stress from patient complaints using the Depression Anxiety Stress Scale-21 (DASS-21) questionnaire. The results of the DASS-21 examination showed that the patient did not experience symptoms of depression (8), anxiety (4), or stress (4). The assessment of quality of life related to oral health was assessed using the Oral Health Impact Profile-14 (OHIP-14) questionnaire. OHIP-14 comprises 14 items that evaluate seven dimensions. Patients rate their frequency at each point from 0 to 4 (0 = never, 1 = very rarely, 2 = sometimes, 3 = often, and 4 = very often). We calculate the total OHIP-14 score by adding the scores from each individual item. The patient's OHIP-14 score of 15 indicated good Oral Health-

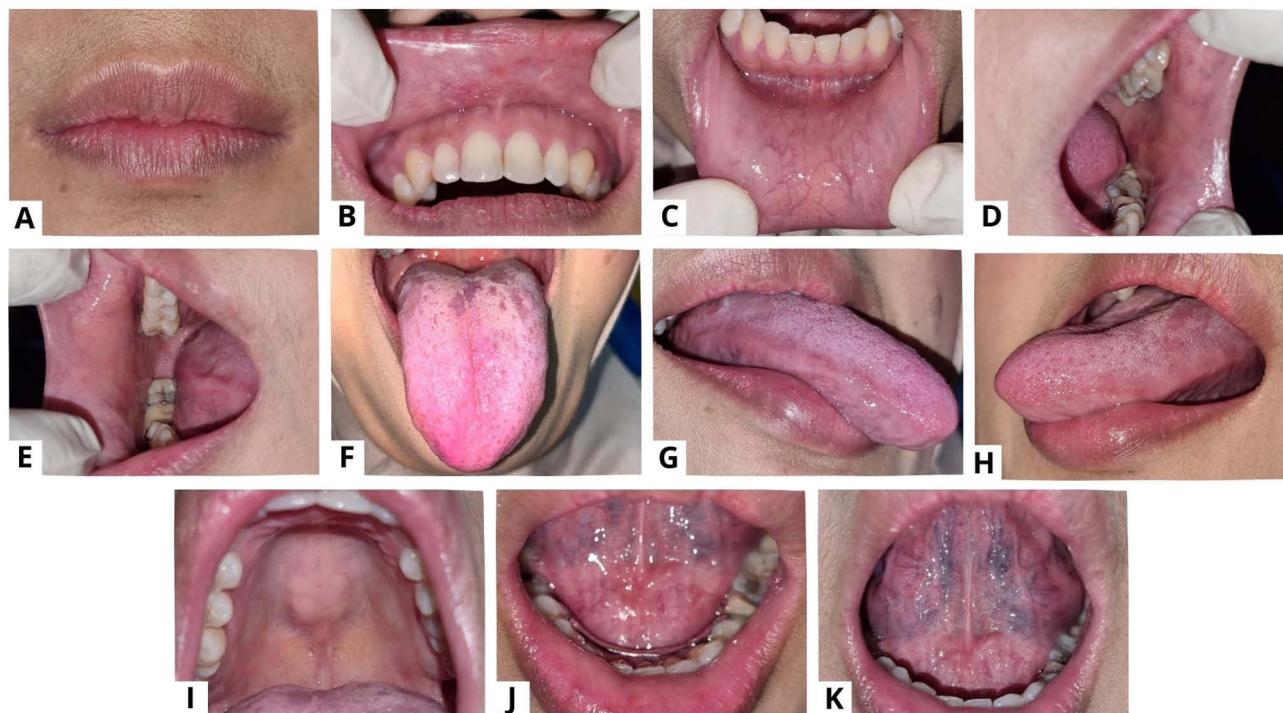


Figure 1 Clinical condition of the patient's oral cavity at the first visit. Dry and exfoliated lips (A); The upper and lower labial mucosa, right and left buccal mucosa, right and left lateral tongue, ventral tongue, floor of mouth, and palatal mucosa are in normal condition (B–E, G–K); geographic tongue on the posterior 1/3 of the dorsal tongue (F).

Related Quality of Life (OHRQoL) (OHIP-14 score 0–18 = good OHRQoL, OHIP-14 score 19–37 = moderate OHRQoL, and OHIP-14 score 38–56 = poor OHRQoL).^{17,18} A complete blood hematology examination showed normal results in all examination parameters (Table 1).

The patient was diagnosed with exfoliative cheilitis, suspected burning mouth syndrome, and a geographic tongue on the posterior 1/3 of the dorsal tongue. Non-pharmacological therapy consists of instructions to clean the teeth and mouth using a soft-bristled toothbrush twice a day in the morning after breakfast and at night before bed, accompanied by brushing the tongue using a tongue scraper or toothbrush in one direction outward. Education is given to patients to avoid eating spicy, sour, or too hot food and to continue a healthy lifestyle, such as not staying up late, drinking at least 2 liters of mineral water per day, and regularly eating fruit and vegetables every day. Pharmacological therapy consists of

Table 1 Hematology Examination Result

Examination	Results	Referral Value	Units
Hemoglobin	12.7	12.0–16.0	g/dL
Leukosit	8.1	4.4–11.3	rb/mm ³
Eritrosit	4.37	4.2–5.4	Juta/mm ³
Hematokrit	37.6	35–47	%
Trombosit	212	150–450	rb/mm ³
MCV	86.0	80–99	fl
MCH	29.1	27–32	pg
MCHC	33.8	30–36	g/dL

Abbreviations: MCV, Mean corpuscular volume; MCH, Mean corpuscular hemoglobin; MCHC, Mean corpuscular hemoglobin concentration.

instructions to gargle with 10 mL of chlorine dioxide zinc-patented mouthwash 3 times a day, gargle for 1 minute, then throw away. Do not eat or drink for 30 minutes after that. Apply a thin layer of petroleum jelly on the upper and lower lips 3 times a day, and take multivitamins (vitamin E 30 IU, vitamin C 750 mg, folic acid 400 mcg, vitamin B1 15 mg, vitamin B2 15 mg, niacin 100 mg, vitamin B6 20 mg, vitamin B12 12 mcg, pantothenic acid 20 mg, and zinc 22.5 mg) once a day after meals. The patient was asked for control 7 days later.

At the second visit, complaints of a sore mouth and burning sensation on the tongue were much reduced since using the prescribed mouthwash. The patient felt comfortable eating, but the food tasted bland. The patient has not followed the instructions for cleaning the tongue because it still feels sore, and the patient did not continue taking multivitamins because the stomach felt bloated. However, the patient felt her mouth dry since three months ago and got worse, so she drank often to reduce this complaint. Complaints started since the patient experienced changes in the menstrual cycle being late and stopping quicker. After further investigation, the patient often urinated at night, lost 5 kg in weight within 3 months, and often felt sore all over the body. The patient was also diagnosed with vitamin D deficiency 20 years ago and received no therapy. Her father and mother have diabetes histories.

On clinical examination at the second visit, it was found that the general condition had improved, the lips and dorsum of the tongue had improved, but there were elongated tongue papillae that were hairy, diffusely bordered, and could not be scraped on the posterior 1/3 of the tongue (Figure 2). Subjective and objective xerostomia examinations were evaluated using the Summated Xerostomia Inventory-Indonesian Version (SXI-ID) questionnaire with a score of 20 and continued with the Clinical Oral Dryness Scoring System (CODS) examination with a score of 3 per 10 (the mirror sticks to the tongue, there is saliva frothy, and no saliva pooling on the floor of the mouth) so that it can be concluded that the patient has mild xerostomia. The unstimulated saliva flow rate was evaluated using a sialometry examination with the splitting method. We ask patients to sit quietly and not talk or chew before the procedure. Patients should rinse their mouths and relax for five minutes before the procedure. After tilting the patient's head slightly forward, they hold their saliva on the floor of their mouth for one minute before spitting it into the tube. We measure saliva volume using a saliva tube indicator. Typically, the test takes five minutes. Salivary flow is mL/min. The results of the unstimulated saliva examination were below the normal value of 0.2 mL/minute (Figure 3).

The diagnosis of suspected burning mouth syndrome was excluded and changed to mild xerostomia on the Challacombe scale. Non-pharmacological therapy is continued and re-educated to brush the tongue after brushing the teeth. The patient was instructed to stop using chlorine dioxide, zinc-patented mouthwash, and multivitamins and to continue applying a thin layer of petroleum jelly to the lips. Pharmacological therapy given to patients is in the form of instructions to apply carboxymethylcellulose (CCMC)-based saliva substitute ethyl p-hydroxybenzoate gel on the left and

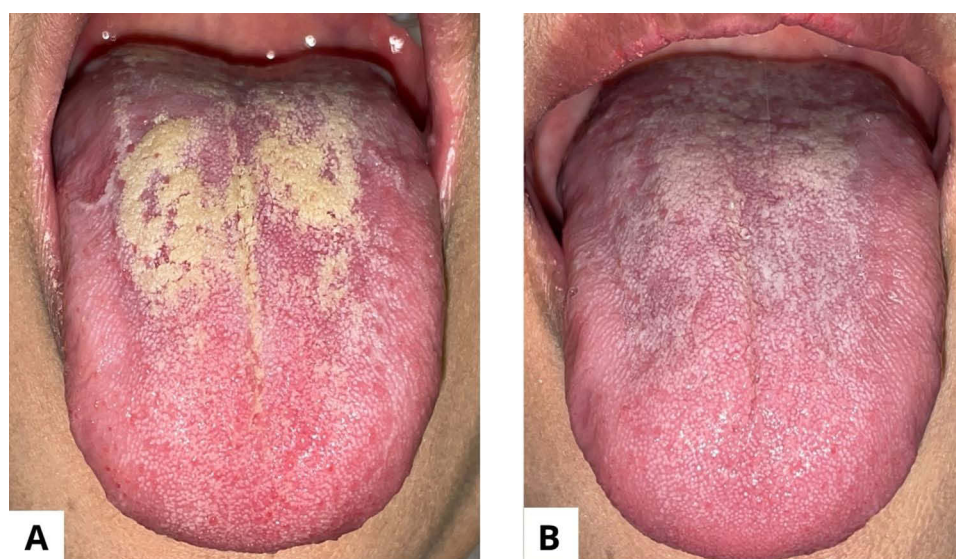


Figure 2 Condition of the patient's tongue at the second visits (A); and third visits (B). There is improvement in the dorsal tongue.

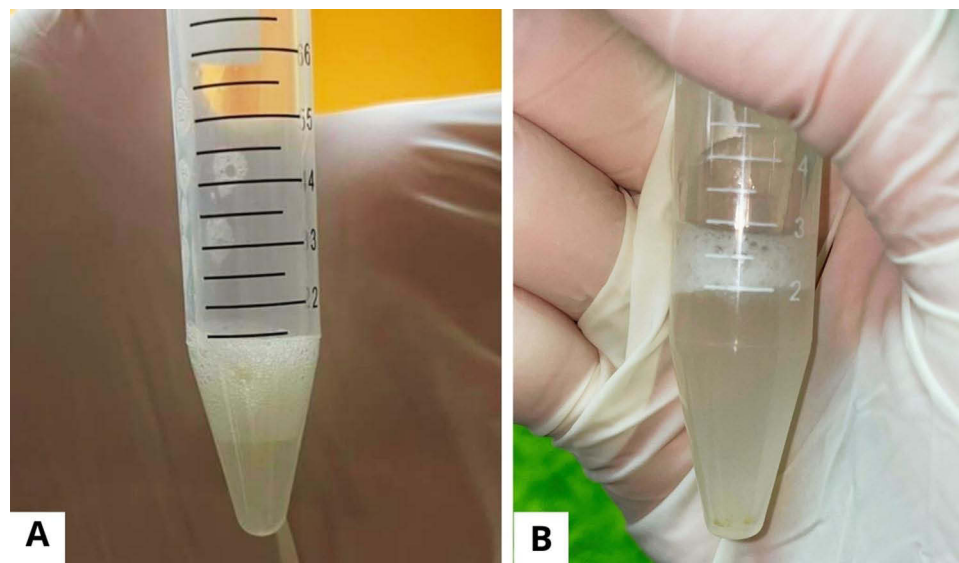


Figure 3 Measurement of unstimulated saliva flow rate at the second visits (A); and third visits (B). Visible changes in the results of measuring the flow rate of unstimulated saliva.

right buccal mucosa, tongue, and floor of the mouth three times a day for 30 minutes before eating, taking neurotropic vitamins (vitamin B1 100 mg, vitamin B6 200 mg, and vitamin B12 200 mg) once a day after eating. The patient was also referred for HbA1c and vitamin D 25 (OH) examinations.

Two weeks later, during the third appointment, the patient no longer complained of a burning feeling on the tongue or a sore mouth. The complaints of feeling dry in the mouth have also disappeared. The patient feels comfortable when eating, and the taste of food has returned to normal. The patient has followed the instructions to clean the tongue twice a day using a tongue scraper. Clinical examination showed that the lips had healed and the dorsum of the tongue had improved (Figure 2). The CODS examination was re-evaluated, and the results showed that the mouth glass was no longer sticking to the tongue, there was no frothy saliva, and there was a pool of saliva on the floor of the mouth, so it was concluded that the patient's xerostomia had healed and the unstimulated saliva flow rate examination with the same protocol as before was normal (0.4 mL/minute) (Figure 3). The patient had diabetes and vitamin D deficiency, as evidenced by HbA1c results of 11% compared to a normal value of <5.7% and vitamin D 25 (OH) results of 12.5 ng/mL compared to a normal value of >30 ng/mL. Non-pharmacological therapy was continued, and the patient was instructed to stop using CCMC-based saliva substitute ethyl p-hydroxybenzoate gel and continue taking neurotropic vitamins, along with taking vitamin D3 at 1000 IU once a day for 10 weeks. The patient was also referred to the internal medicine department for diabetes management.

Discussion

Diabetes and vitamin D deficiency are difficult to diagnose since patients are often unaware of their conditions. This disease is typically identified accidentally after a laboratory check. Early detection and improved blood sugar regulation are the main goals of any diabetes treatment.^{1,6,8} In this case, the patient does not realize that she has diabetes. The patient was also unaware that he had prolonged vitamin D deficiency because there were no symptoms after being diagnosed with vitamin D deficiency 20 years ago. Based on risk factors in the patient, there is a family history of diabetes, specifically from both of the patient's parents; a history of untreated vitamin D deficiency; hormonal changes associated with irregular menstrual cycles; and being overweight based on the patient's body mass index (BMI) with a score 28.3. Weight loss, frequent urination at night, and body aches are indicators of diabetes and vitamin D deficiency in patients. Signs and symptoms in the oral cavity include dry lips and exfoliation; the mouth feels dry, so the patient often drinks water to get rid of the dry feeling; the tongue feels sore and burning; and there is a decrease in taste. The patient's risk factors, symptoms, and signs indicate a vitamin D 25 (OH) deficiency and a HbA1c examination referral.

Prolonged and uncontrolled vitamin D deficiency can be associated with diabetes, such as in patients who were previously diagnosed with vitamin D deficiency but were not treated. Vitamin D stimulates the pancreas to produce insulin by regulating calcium levels through cell membranes and intracellular calcium, as well as pancreatic tissue and various immune system cell types expressing vitamin D receptors (VDR).^{9,10} According to previous studies, variant forms in the vitamin D receptor gene have an impact on the vitamin D receptor protein's functionality. A low level of vitamin D has been linked to metabolic syndrome, reduced insulin synthesis, and increased insulin resistance. Beta cell dysfunction and insulin resistance are also associated with low levels of vitamin D and a significant elevation in HbA1c, which can be seen from the patient's HbA1c results in this case being above normal.^{9,10} Vitamin D deficiency can stimulate the lipogenesis process, leading to an indirect rise in body fat. Furthermore, there appears to be a correlation between the expression of VDR in adipose tissue and the lack of vitamin D in obese people.¹⁹ Low levels of vitamin D will trigger the activation of VDR in adipocytes, leading to a negative impact on energy metabolism, which eventually raises the risk of obesity. This is consistent with other studies showing an association between vitamin D levels and body mass index in people with diabetes compared to people without diabetes.¹⁹ In line with the patient's BMI which is included in the overweight category.

Diabetes-related xerostomia may be associated with dehydration from hyperglycemia, diabetic neuropathy, structural alterations in the salivary glands, and polyuria, which lowers saliva production. Increased diuresis in patients causes a significant decrease in extracellular fluid, which directly affects saliva production. The symptoms of xerostomia are exacerbated during periods of metabolic problems due to dehydration, which raises the blood vessel's osmotic gradient in relation to the salivary glands, reducing salivary output. Prospective observational studies have found scientific evidence of cellular changes caused by diabetes mellitus and reduced saliva flow, such as the examination of patient saliva flow rates, which show below-normal results.^{2,7,10} Several studies have shown that decreased salivary flow rate and xerostomia are significantly associated with diabetes. Sanchez et al in a cross-sectional study showed that half of diabetic patients experienced xerostomia (52.4%) and almost half experienced hyposalivation (41.1%). Another study by Ashwaq et al also showed significant differences in salivary metabolites between individuals with diabetes and healthy controls, where salivary metabolites, including vitamin D, were significantly lower than healthy individuals.^{20,21}

A vitamin D deficiency, xerostomia, and diabetes are all potentially associated with the burning tongue and taste alterations that patients experience. Decreased saliva flow rate and dry conditions in the oral cavity cause sensory neuropathy. Furthermore, burning tongue symptoms have been linked to deficiencies in micronutrient homeostasis, including vitamin D, which can cause neurodegenerative alterations and peripheral or central neuropathy.²² Microvascular deficits, sensory neuropathy, or non-specific satiety effects due to persistently elevated blood glucose concentrations may cause taste alteration in diabetics.^{14–16}

In the initial therapy, we administered a chlorine dioxide zinc-patented mouthwash to reduce complaints of burning tongue and act as an antiseptic in the patient's oral cavity. This mouthwash contains a strong oxidizer that can kill bacteria and has properties beneficial to the healing process of cells, especially fibroblast cells. Petroleum jelly, a covering agent that protects the outer and inner skin by preventing natural water loss, moisturizes the patient's dry lips.²¹ Treatment for xerostomia patients depends on the severity of the xerostomia. Giving carboxymethylcellulose (CCMC)-based saliva substitute, which is using ethyl p-hydroxybenzoate gel, can overcome complaints of xerostomia. Ethyl p-hydroxybenzoate gel can stabilize the pH of the mouth to neutral, thereby increasing the saliva flow rate. Therefore, at the third visit, the saliva flow rate increased, and there were no complaints of dry mouth.²²

Conclusion

Oral complaints such as a burning tongue and changes in taste associated with xerostomia can be related to systemic diseases such as diabetes and vitamin D deficiency, both of which are often without clinical symptoms, and the patient is unaware of them. A complete anamnesis, including family medical history, is needed to identify risk factors for undiagnosed diabetes and vitamin D deficiency. Furthermore, objective examinations and supporting tests like HbA1c and vitamin D 25 (OH) are essential to determine the root cause of the patient's complaints. These tests also serve as fundamental considerations for therapeutic and appropriate referrals, ensuring patients receive optimal treatment.

Consent Statements

The patient has approved and written informed consent for the publication of this case report, including the images. The institution has also approved the publication of this articles.

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Disclosure

The author(s) report no conflicts of interest in this work.

References

1. Siva Kumar B. A negative impact on quality of life: silent diabetes. *Acta Scientific Clin Case Rep.* 2024;21–23. doi:10.31080/ASCR.2024.05.0498.
2. Ismail L, Materwala H, Al Kaabi J. Association of risk factors with type 2 diabetes: a systematic review. *Comput Struct Biotechnol J.* 2021;19:1759–1785. doi:10.1016/j.csbj.2021.03.003
3. International Diabetes Federation. IDF Diabetes Atlas. 2021. Available from: <https://diabetesatlas.org/data/en/world/>. Accessed November 22, 2024.
4. World Health Organization. Diabetes. 2023. Available from: <https://www.who.int/news-room/fact-sheets/detail/diabetes>. Accessed November 22, 2024.
5. Glick M, Greenberg MS, Lockhart PB, et al. *Burket's Oral Medicine - Michael Glick*. 13th ed. Wiley; 2021:1136. ISBN: 978-1-119-59781-0.
6. Cui A, Zhang T, Xiao P, Fan Z, Wang H, Zhuang Y. Global and regional prevalence of vitamin D deficiency in population-based studies from 2000 to 2022: a pooled analysis of 7.9 million participants. *Front Nutr.* 2023;10:1. doi:10.3389/fnut.2023.1070808
7. Wimalawansa SJ. Associations of vitamin D with insulin resistance, obesity, type 2 diabetes, and metabolic syndrome. *J Steroid Biochem Mol Biol.* 2018;175:177–189. doi:10.1016/j.jsbmb.2016.09.017
8. Tantri A, Soenarto R, Firdaus R, Theresia S, Anakotta V. Low incidence of vitamin D levels deficiency in anesthesiology residents: a cross-sectional, retrospective study. *Bali J Anaesthesiol.* 2022;6(4):210. doi:10.4103/bjoa.bjoa_172_22
9. Vijay GS, Ghonge S, Vajjala SM, Palal D. Prevalence of Vitamin D deficiency in type 2 diabetes mellitus patients: a cross-sectional study. *Cureus.* 2023. doi:10.7759/cureus.38952
10. Khudayar M, Nadeem A, Lodi MN, et al. The association between deficiency of Vitamin D and diabetes mellitus type. *Cureus.* 2022;2:1.
11. Silveira Lessa L, Duarte Simões Pires P, Ceretta RA, et al. Meta-analysis of prevalence of xerostomia in diabetes mellitus. *Int Arch Med.* 2015;8:1. doi:10.3823/1823
12. Piliang A, Zakiawati D, Nur'aeny N. Xerostomia as a potential condition in patients Covid-19 with tetanus: a case report. *Makassar Dent J.* 2022;11(1):21–24. doi:10.35856/mdj.v11i1.501
13. Agostini BA, Cericato GO, da SER, et al. How common is dry mouth? Systematic review and meta-regression analysis of prevalence estimates. *Braz Dent J.* 2018;29(6):606–618. doi:10.1590/0103-6440201802302
14. Asan MF, Babu GS, Ajila V, Achalli S. Taste disorders in diabetes – an insight. *Rom J Diabetes Nutr Metab Dis.* 2022;29:268–272.
15. Dumić Kubat K, Catamo E, Robino A, et al. Article 797920 Rade Vukovic, The institute for health protection of mother and child Serbia. *Front Nutr.* 2022;1:1.
16. Alsabbagh R, Ouanounou A. Burning mouth syndrome: etiology, clinical presentations, and treatment alternatives. *Dent Rev.* 2022;2(1):100036. doi:10.1016/j.dentre.2022.100036
17. Campos LA, Peltomäki T, Marôco J, Jadb C. Use of Oral Health Impact Profile-14 (OHIP-14) in different contexts. what is being measured? *Int J Environ Res Public Health.* 2021;18(24):13412. doi:10.3390/ijerph182413412
18. Bakti F, Dewi T. Evaluation of oral health-related quality of life in patient with herpes-associated erythema multiforme: a unique case report. *Int Med Case Rep J.* 2024;17:253–259. doi:10.2147/IMCRJ.S456301
19. Md Isa Z, Amsah N, Ahmad N. The impact of Vitamin D deficiency and insufficiency on the outcome of type 2 diabetes mellitus patients: a systematic review. *Nutrients.* 2023;15(10):2310. doi:10.3390/nu15102310
20. Gholizadeh N, Sheykhbahaie N. *Micronutrients Status as a Contributing Factor in secondary Burning Mouth Syndrome: A Review of the Literature*. Vol. 7. Health Science Reports. John Wiley and Sons Inc; 2024.
21. Ruslijanto H, Amtha R, Meiyanti ME, Febrina S. *Obat Topikal Untuk Lesi Mulut: Pemilihan Dan Cara Aplikasi [Topical Medications for Oral Lesions: Selection and Application Methods]*. Juwono L, editor. Jakarta: Penerbit Buku Kedokteran EGC; 2019:3–5.
22. Wicaksono IK, Wahyuni IS. Exploration of the efficacy and safety of oral moisturizing agents for dry mouth and xerostomia: a systematic review. *Int J Appl Pharm.* 2022;14:7–11. doi:10.22159/ijap.2022.v14s4.OP05

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