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REVIEW ARTICLE

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Oral Mucosal Changes in Acrylate Prosthesis Wearers Among Diabetic Patients: A Review Article

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Abstract

Diabetes mellitus (DM) is one of the significant health problems in the world. Diabetes affects most parts of the human organism, and the oral cavity is no exception. Among oral manifestations related to DM are dry mouth, tooth decay, periodontal disease, gingivitis, oral candidiasis, burning mouth syndrome, disorders of taste, oral lichen planus, geographic tongue, fissured tongue, delayed wound healing, increased incidence of infection, salivary dysfunction and neurosensory disorders. According to the literature, edentulous patients are more likely to have DM in comparison to the nondiabetic population. The effect of total prostheses on the oral mucosa (OM) has been the subject of many scientific studies. This study aimed to investigate existing evidence related to changes in the OM in DM patients who are wearers of total acrylic prostheses.

Based on the reviewed literature, changes in the OM are much more pronounced in DM patients wearing acrylate prostheses and are caused by severe inflammation and delayed keratinization. A total acrylate prosthesis introduces additional trauma, inflammation, and stress in DM patients. **(International Journal of Biomedicine. 2023;13(4):221-227.)**

Keywords: diabetes mellitus • acrylate prosthesis • oral mucosa • cytological changes

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Abbreviations

BMS, burning mouth syndrome; **DM**, diabetes mellitus; **DS**, denture stomatitis; **OLP**, oral lichen planus; **OM**, oral mucosa; **T1DM**, type 1 DM; **T2DM**, type 2 DM.

Introduction

Diabetes mellitus (DM) is one of the significant health problems in the world. It is a metabolic disorder characterized by chronic hyperglycemia and related disturbances of fat and protein metabolism due to defects in insulin secretion, action, or both.[(1)]

Type 1 DM (T1DM), previously known as insulin-dependent DM or juvenile-onset diabetes, affects 5%-10% of all diagnosed cases of diabetes. Type 2 DM (T2DM) makes up the vast majority of cases – 80%-90%.[(2)]

Several pathogenic processes are involved in the development of diabetes. These range from autoimmune destruction of the β-cells of the pancreas with consequent

insulin deficiency to abnormalities resulting in insulin action resistance.

Diabetes affects most parts of the human organism, and the oral cavity is no exception.[3] Among oral manifestations related to DM are dry mouth, tooth decay, periodontal disease, gingivitis, oral candidiasis, burning mouth syndrome (BMS), disorders of taste, oral lichen planus (OLP), geographic tongue, fissured tongue, delayed wound healing, increased incidence of infection, salivary dysfunction and neurosensory disorders.[4]

The complete absence of teeth may be due to many factors, such as caries, periodontal pathologies, trauma, and oral cancer.[5] According to the literature, edentulous patients are 1.82 times more likely to have DM in comparison to the nondiabetic population.[6] Most edentulous patients are rehabilitated by application of total prostheses, which replace the lost bone and teeth. Complete dentures restore the function of the jaw-tooth system of the face. The effect of total prostheses on the oral mucosa (OM) has been the subject of many scientific studies.[1-47]When OM is covered by a denture, it is sandwiched between the denture and the underlying bone. Although protected from the direct effects of stimulation by food, it is subjected to the traumatic effect of the denture.[7] It is not surprising that there is no general agreement on the effects of dentures on OM since there are many factors that may alter them, such as the type of denture, the type of denture base material, the denture hygiene, the duration of denture wear each day, the length of denture exposure, the physical condition of the denture and dentition in the opposing arch.[7]

During mastication, the OM beneath the denture is critical in distributing occlusal loads to the underlying bony ridge over a large denture-supporting tissue interface. [8-10] Clinical assessment of the supporting tissue in complete denture patients is an important step in treatment planning, as mucosal displacement can disturb the denture balance. The dentist should adequately examine the mucosa, and the clinical scenario differs from patient to patient.[11]

The OM can be classified into lining mucosa, masticatory mucosa, and specialized mucosa. The masticatory mucosa is found on the gingiva and the hard palate. It has a keratinized and, in some areas, a parakeratinized stratified squamous epithelium. Parakeratinized epithelium is similar to keratinized epithelium except that the superficial cells do not lose their nuclei, and their cytoplasm does not stain intensely with eosin. The nuclei of the parakeratinized cells are pyknotic (highly condensed) and remain until the cells are exfoliated. The keratinized epithelium of the masticatory mucosa resembles that of the skin but lacks a stratum lucidum. The underlying lamina propria consists of a thick papillary layer of loose connective tissue that contains blood vessels and nerves; some send bare axon endings into the epithelium as sensory receptors, and some end in Meissner's corpuscules. Deep to the lamina propria is a reticular layer of denser connective tissue. As in the skin, the depth and number of connective tissue papillae contribute to the relative immobility of the masticatory mucosa, thus protecting it from frictional and shearing stress. At the midline of the hard palate, in the palatine raphe, the mucosa adheres firmly to the underlying bone. The reticular layer of the lamina propria blends with the periosteum; thus, there is no submucosa. The same is true of the gingiva. Where there is a submucosa underlying the lamina propria on the hard palate, it contains adipose tissue anteriorly (fatty zone) and mucous glands posteriorly (glandular area) that are continuous with those of the soft palate. In the submucosal regions, thick collagenous bands extend from the mucosa to the bone.[12]

Acrylic-based resins are frequently used in daily dental practice for prostheses as they can provide essential properties and have the necessary characteristics for their use in diverse functions. During the polymerization of these materials, the residual monomer is released, which may be cytotoxic to the OM. The released monomer depends on the modes of polymerization as well as on the degradation of the polymer under certain conditions that are present in the oral cavity.[13]

Since prostheses are generally foreign bodies in the oral cavity, mucosal lesions in their undersurface may be considered a rather normal occurrence. Their frequency is thought to be even greater in patients suffering from DM, considering the sensitivity of the OM in these patients.

Given all the oral manifestations in DM mentioned previously, the wearing of complete dentures in diabetic patients is complicated by the higher incidence and gravity of oral mucosal lesions compared to nondiabetic patients. Due to the complex nature of the disease, changes in the oral epithelium under total acrylic prostheses will be a clinical challenge in finding methods and treatments to manage and prevent these changes in patients with total acrylic prostheses suffering from DM. There are experimental studies in the literature designed to analyze the changes that occur under total prosthesis in patients with DM and the factors that may affect these patients.

This study aimed to investigate existing evidence related to changes in the OM in DM patients who are wearers of total acrylic prostheses.

Material and Methods

We reviewed published data on the role of Oral Mucosal Changes in Acrylate Prosthesis Wearers Among Diabetic Patients, searching through PubMed, MEDLINE and Scopus, using search terms with suitable keywords. The search terms were "diabetes mellitus," "oral mucosal changes," "acrylate prosthesis," and "mucosal cytological changes." Studies have been classified according to the year of publication, respective pathologies, number of cases, and conclusion.

Results

Our focus was on 26 articles published between 1982 and 2022 describing oral mucosal lesions in patients with diabetes, many of whom are total acrylate denture wearers.

Table 1 summarizes the findings in the analyzed articles. In 3 studies with 340 DM subjects with xerostomia, all had dry mouth sensitivity and decreased saliva.[15-17] In 2 studies involving 740 denture wearers, xerostomia had an adverse effect on oral functions.[14,19]

Table 1.

Summary of the reviewed articles.

Author(s)	Year of publication	Type of study	Pathology	No. of cases	Conclusion
Hoseini A, et al. [15]	2017	CCS	Xerostomia	150	Diabetic patients (T1DM and T2DM) revealed a lower salivary flow rate and higher xerostomia than healthy controls.
Eldarrat AH, et al. [16]	2011	QS	Xerostomia	100	Diabetic patients who do not carefully control their blood glucose levels will be at high risk of systemic and oral complications.
Cicmil A, et al. [17]	2020	CCS	Xerostomia	90	The findings have indicated that a decreased salivary flow rate could significantly impact oral health status in type 2 diabetics.
Al-Dwairi Z, et al. [14]	2014	QS	Xerostomia	455	Xerostomia adversely affects oral functions and overall satisfaction with dentures.
Aslam A. [19]	2017	QS	Xerostomia	285	Dry mouth appears to have a significant impact on the oral function in denture wearers.
Soell M, et al. [20]	2007	RA	Candidiasis	10 S	Diabetics have an increased predisposition to the manifestation of oral diseases like candidiasis, which is associated with poor glycemic control and therapeutic dentures.
Lotfi-Kamran MH, et al. [21]	2009	CCS	Candidiasis	92	Mycological findings from the study revealed that diabetes mellitus can increase colonization of Candida in denture and mouth
Webb BC, et al. [22]	1998	RA	Candidiasis	N\A	This study observed that the use of antifungal and antibacterial agents effectively reduces the number of Candida and aerobic bacteria from the prosthesis surface.
Ganapathy DM, et al. [23]	2013	POS	Candidiasis	15	A positive correlation was observed between oral candidiasis in complete denture-bearing mucosa and elevated blood glucose levels and oral hypoglycemic drug therapy has a positive effect in controlling oral Candida colonization in complete denture wearers with T2DM.
Cristina de Lima D, et al. [24]	2008	CCS	Oral mucosal lesion	60	No significant differences were observed in salivary flow, denture retention, or oral lesions in diabetic and nondiabetic subjects.
Trentin MS, et al. [25]	2017	CSS	Prosthetic stomatitis	250	Diabetic patients with complete upper denture presented with higher incidence of prosthetic stomatitis compared to non-diabetics
Khatibi M, et al. [26]	2015	CS	Prosthetic stomatitis	112	A significant relationship between T2DM and the prevalence of denture stomatitis was found.
Bookout GP, et al. [27]	2022	RA	BMS	N/A	The diagnosis and management of burning mouth syndrome are challenging and require a multidisciplinary approach - medical and psychological. The cause of the disorder remains unknown, and the treatment is empirical.
Aravindhan R, et al.[28]	2014	RA	BMS	N/A	The exact cause of BMS often is difficult to pinpoint and is probably of multifactorial origin and may be idiopathic.
Nada A, et al. [29]	2020	CSS	BMS	250	BMS in patients with diabetic neuropathy is complicated. The contributing oral factors are associated with poor metabolic control.
Mukatash-Nimri G, et al. [30]	2017	CCS	BMS	129	Significant positive associations were found between local factors (i.e., wearing complete dentures with unsatisfactory retention or jaw relationship, dry mouth, or candidiasis) and patients suffering from burning mouth sensation.
Al-Maskari AY, et al.[31]	2011	RA	Taste disorder	N/A	Oral manifestations and complications in patients with diabetes mellitus have been recognized and reported recently as a major complication of diabetes mellitus.
Ship JA [32]	2003	RA	Taste disorder	N/A	The goal of therapy is to promote oral health in patients with diabetes, to help prevent and diagnose diabetes in dental patients receiving routine stomatological care, and to enhance the quality of life for patients with this incurable disease.
Otero Rey EM, et al. [33]	2018	SR-MTA	Lichen planus	22 -S	In this study, the prevalence of planus was found in patients with diabetes, which ranged from 0.5% to 6.1%. % with a relative risk of 1.4
Shen ZY, et al. [34]	2012 [35]	RS	Lichen planus	518	The incidence of the history of systemic diseases, including DM, was not higher than expected when compared with the incidence reported in the general population.
Mozaffari HR, et al. [35]	2016	MTA	Lichen planus	11	The meta-analysis showed the risk of OLP in DM was higher compared with control subjects.
Kaomongkolgit R [36]	2010	CR	Lichen planus	1	The dental materials of the denture base play a fundamental role in the occurrence of OLP in the oral mucosa, especially the overextended denture flange that can induce a lichenoid reaction.

Table 1 (continued)

Summary of the reviewed articles.

Author(s)	Year of publication	Type of study	Pathology	No. of cases	Conclusion
Mneizel T. [38]	2005	IVS	Changes in the degree of keratinization	25	The wearing of complete acrylic dentures disturbs the denture-supporting epithelium of the palatal mucosa and results in decreased levels of epithelial keratinization.
Radke U, et al. [40]	2014	IVS	Changes in the degree of keratinization	30	Stimulation of the denture-bearing mucosa with astringent gum massage resulted in the gradual increase in keratinization.
Lindholm K, et al.[46]	1982	CCS	Changes in the degree of keratinization	67	Palatal keratinization under dentures was lower than the keratinization in the control group.
Farhan RS and as LS. [47]	2018	CCS	Changes in the degree of keratinization	75	Diabetes produces definite cytomorphometric changes in the oral mucosal cells of patients. The results suggested that nuclear diameter increased while cytoplasmic diameter decreased in T2M patients. The most predominant oral manifestations found in T2DM patients were periodontal disease and oral dryness.

CCS - *Case-Control Study*, CSS - *Cross-sectional study*, QS - *Quantitative study, RA - Review Article,* CS - *Cohort Study, POS - Prospective observational study*, *SR–MTA - Systematic review and meta-analysis, RS - Retrospectively Study*, *IVS - In Vivo Study, N/A – not applicable.*

A meta-analysis of 10 studies and 2 studies [21,23] with 107 DM patients showed a high incidence of candidiasis. One review article showed that the incidence of oral candidiasis in denture wearers has significantly increased. [20]

In a study by de Lima et al.,[24] which included 60 patients with oral lesions, there was no association between these lesions and the presence or absence of DM.Two studies with 362 patients showed that denture wearing in patients with DM was associated with an increased incidence of denture stomatitis (DS). In a study by Trentin et al.,[25] compared to nondiabetics, the stomatological manifestations were observed more frequently in T2DM patients and included pseudomembranous candidiasis, lichen planus, lingual varices, xerostomia, and prosthetic stomatitis. Among 129 patients with a mean age of 59.4 years, denture wear was associated with BMS in 58% of cases in a study by Mukatash-Nimri.[30]

In a review by Al-Maskari et al.,[31] among the many factors that influence changes in taste sensations in the oral cavity of DM patients, attention was also paid to the dysfunction of saliva, which contributes to changes in taste sensations.

A systematic review and meta-analysis performed by Otero Rey et al.[33] included 22 studies answering the following questions: «What is the prevalence and risk of OLP among patients with DM?» and «What is the prevalence and risk of DM among patients with OLP?» Twelve studies assessed the prevalence of DM among patients with OLP and reported ranges from 1.6% to 37.7% with a relative risk of 2.432. Ten studies assessed the prevalence of OLP among patients with DM and showed a prevalence ranging from 0.5% to 6.1% with a relative risk of 1.4.

A group of authors showed a decrease in the level of epithelial keratinization among those wearing complete acrylic dentures.[38,40,46] Farhan and Yas[47] conducted cytomorphometric measurements of oral mucosal cells in T2DM patients and healthy control subjects using exfoliated cytology smears. An eyepiece micrometer was used to take mean values of nuclear diameter (ND), cytoplasmic diameter (CyD), and the ratio of 2 diameters (N/C). The results showed a statistically significant increase in ND for buccal mucosa and the tongue, while CyD was decreased in T2DM patients; as a result, the N/C ratio for both the tongue and buccal mucosa significantly increased in T2DM patients, compared to controls.

Discussion

Given all the previously aforementioned oral manifestations in DM, the wearing of complete dentures in these patients is complicated by the higher incidence and gravity of oral mucosal lesions, compared to nondiabetic patients. Many studies describe the chronic complications of DM due to various metabolic and hemodynamic disturbances that mainly target vascular endothelial cells. The oral cavity is especially prone to complications.

One of the oral manifestations of patients with diabetes is xerostomia. Xerostomia is the subjective feeling of dry mouth, which is, in fact, a symptom, not a disease.[14] It is well known that a significant reduction of salivary flow leading to xerostomia is the most common oral manifestation of diabetes.[15] Ana Cicmil et al.[17] found a high presence of xerostomia in DM patients, compared to nondiabetics; these changes were especially pronounced in patients with poor glycemic control.According to Al-Dwairi et al.,[18] xerostomia adversely affects oral functions and overall satisfaction with dentures.

In wearers of a complete denture, the wetting mechanics of saliva are necessary to assist in the retention of prostheses. It has been reported that complete denture patients with xerostomia have more intense sore spots than patients with normal salivary flow. Also, OM becomes dry and tends to crack and ulcerate, which makes wearing removable prostheses uncomfortable.[19]

Diabetics have an increased predisposition to the manifestations of oral diseases like candidiasis, which

is associated with poor glycemic control and therapeutic dentures.[20] Wearing a complete denture is also known as an additional risk factor, which can promote colonization of *Candida*, produce *Candidal* biofilm, and result in oral candidiasis.[21]

Acrylic dentures are an important predisposing factor for oral candidiasis as these appliances, usually ill-fitting with suboptimal hygiene, act as reservoirs of infection.For instance, high salivary yeast counts are much more common in complete denture wearers than in dentate individuals.[22] In a study by Ganathy et al.,[23]15 subjects with complete acrylic prosthesis and DM were analyzed. The sample collection was carried out before and after oral hypoglycemicic drug intervention by swabbing the rugal surfaces of the palatal mucosa, followed by culture. A positive correlation was observed between oral candidiasis in the mucosa of complete denture wearers and elevated blood glucose levels. Oral hypoglycemic drug therapy positively controlled oral colonization by *Candida* in complete denture wearers with T2DM.In contrast, a study by de Lima et al. did not find significant differences between diabetic and nondiabetic subjects wearing complete dentures concerning salivary flow, salivary buffering capacity, denture retention, and oral mucosal lesions.

In a study by Trentin et al.,[25] diabetic patients with complete upper dentures had a higher incidence of DS than nondiabetics. This pathology is characterized by an erythematous lesion confined to the prosthesis area and may present with painful symptomatology. According to this study, T2DM metabolic control and oral lesions may have a significant relationship, as diabetic patients with complete upper dentures showed a 7.4 times higher risk than nondiabetics for developing DS.

A study by Khatibi et al.[26] showed a statistically significant association between T2DM and DS. A higher frequency of DS in DM patients indicates that DM causes alterations in the function of the host immune cells like polymorphonuclear leukocytes, monocytes, and macrophages.

BMS, presenting as burning pain, is a chronic, debilitating oral pain disorder characterized by generalized burning sensations on the tongue and other OM, with no discernible medical or dental causes.[27] Most individuals describe this symptom as a burning, tingling, scalding, annoying, tender, or numb feeling of the OM, most commonly involving the anterior two-thirds of the tongue, dorsum and lateral borders of the tongue, anterior portion of the hard palate, and labial mucosa.[28]

DM is one of the systemic conditions associated with secondary BMS. Burning mouth sensation in diabetic patients has been attributed to poor glycemic control, metabolic alterations in the OM, angiopathy, and neuropathy.[29]

Many factors have been implicated in altered taste sensation in the oral cavity.Taste dysfunction has been reported to occur more frequently in patients with poorly controlled DM, compared to healthy controls. Diabetic patients who suffer from neuropathy have a higher taste sensitivity threshold. Taste disturbance has also been reported to lead to poor glycemic control by inhibiting the ability to maintain a good diet.

OLP is a mucocutaneous inflammatory chronic disease with an overall prevalence of 1.27%.[33] Clinically, OLP may occur in 6 clinical variants: reticular, papular, plaque-like, erosive, atrophic, and bullous.[34] Because of the varied clinical forms of OLP, it is associated with various other systemic conditions, including DM. This association may be due to the endocrine dysfunction in DM and immunological defects.[35] Certain antidiabetic drugs in DM patients can cause an allergic reaction with a lichenoid-resulting response.[36] Also, denture-based dental materials play a fundamental role in the appearance of OLP in the OM. In the study by Rath et al.,[37] related to the impact of total prostheses on OLP, it was observed that the denture flange at the maxillary labial vestibule was a bit overextended. This might have caused repeated soft tissue impingement, causing a frank lesion with an exuberant lichenoid response.

Besides the previously mentioned oral manifestations in DM, several researchers have inquired about cellular changes in the OM of these patients. Cytology examination of the epithelial cells immediately under the acrylate prosthesis is an optimal non-invasive method. By exfoliative cytology, the epithelial cells are shed from the mucosal surface and applied to the glass slide. An appropriate cytobrush best obtains these. Some of these studies show that the oral epithelium under the prosthesis becomes more keratinized, while others show that the epithelium remains non-keratinized.[38] Some of the studies found that there is not only a quantitative reduction of keratinization but also acanthosis.[39-45] Keratinization, also termed cornification, is a process of cytodifferentiation during which the keratinocytes undergo maturation from their post-germinative state (basal layer) to finally differentiated, hardened cell filled with keratin, namely, stratum corneum. [39-45]

In a study by Lindfolm et al.,[46] the cytological effects of denture wear on the underlying palatal mucosa were analyzed in 67 complete denture patients and 44 persons without dentures (controls). Palatal keratinization under dentures was lower than the keratinization in the control group. Continuous denture wear, compared to daytime wear only did not reduce palatal keratinization. Mneizel,[38] using exfoliative cytology, showed that wearing complete maxillary acrylic dentures disturbs the denture-supporting epithelium of the palatal mucosa and decreases keratinization levels.

Conclusion

Based on the reviewed literature, the oral mucosal lesions in total acrylate prosthesis wearers may be summarized as follows: xerostomia, candidiasis, DS, oral mucosal lesions, BMS, taste disorders, OLP, and changes in degree of keratinization. There is a general agreement in the analyzed studies that in total acrylate prosthesis wearers who have DM, the gravity of the lesions is significantly higher than in nondiabetics. In DM patients, the keratinization of the oral mucosal cells is delayed. Adequate hygiene level is a contributing factor for fewer complications.

Competing Interests

The authors declare that they have no competing interests.

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