

# Local Factors for Development of Denture Stomatitis and Strategies for Their Management

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## ABSTRACT

One of the most frequent diseases of oral cavity in elderly people that use removable dentures is denture stomatitis. Large set of local factors predispose towards the occurrence of denture stomatitis – quantity and Ph of saliva, violations of oral mucosa integrity, surface characteristics of the denture base materials, the maintenance of dentures and oral cavity hygiene, the period of using one and the same dentures, etc. Development of denture stomatitis can deteriorate not only the oral health but general health status of patients, hence their quality of life. This predefines problem's great social significance. The purpose of this review was to analyse the local factors that make impact on development of denture stomatitis in complete dentures wearers, the contemporary prevention strategies and the role of the patients in their realization. Successful prevention of the disease could be achieved with the application of complex approach that includes evaluation of all the general and local factors and implementation of multi-component strategy for the management of their influence. The active collaboration with patient is essential for successful prevention of the denture stomatitis.

**Keywords:** denture stomatitis; local factors; strategies for prevention

## INTRODUCTION

The main task of the prosthetic treatment of edentulous patients is achievement of satisfactory functional and aesthetical effect with complete denture. The opportunity for supporting sustainable health of oral cavity is of great importance for successful rehabilitation of the masticatory system.

The oral microflora includes great versatility of microorganisms that do not cause diseases [1]. Unfortunately, some prerequisites could provoke the manifestation of pathogenicity on behalf of microorganisms that normally inhabit the oral cavity. The presence of saliva promotes the formation along the surface of oral structures and along the surface of denture constructions of the so-called "saliva pellicle" that is a layer of glycoproteins and immunoglobulins and is basis for the formation of biofilm that contains proteins, epithelium cells, food particles and microorganisms [2]. The biofilm compounds vary within broad limits depending on the surface features onto which these are formed, the conditions inside the oral cavity such as Ph, the saliva quantity and the general health status of the individual [3]. The impact onto the compounds of oral microflora is made by many factors such as oral hygiene, diet rich in low-molecular carbohydrates, reactivity of immune system and various diseases of the patient [4].

Oral cavity disease that is observed most often in complete denture wearers is the denture stomatitis [5]. The frequency of disease occurrence is high and according to some researches it varies between 15% and 70% [6].

The denture stomatitis is an inflammatory reaction of oral mucous membrane provoked by a complex of factors. The aetiology of denture stomatitis could include various microorganisms such as bacteria of

the species - Staphylococcus, Streptococcus, Fusobacterium and Bacteroides [7]. Nevertheless, the main causers are representatives of the Candida species - especially Candida albicans. We also find Candida glabrata, Candida tropicalis, Candida krusei, Candida parapsilosis [8]. The microorganisms form colonies until the eighth hour of their stay inside the oral cavity. The created conglomerate is thickened and tightly binds to the denture surface thus hindering it being influenced by antibacterial and antimycotic agents after the 24<sup>th</sup> hour [9].

The denture stomatitis could be asymptotically or cause various degree of patient's discomfort. Patients complain from pains, stinging and itching on the oral mucosa, bad breath, change of taste sensation. The clinical finding in view of the generally accepted classification by Newton [10] could be three types: I type – localized inflammatory sections being individual hyperaemia spots; 2<sup>nd</sup> type – diffuse erythema and mucous membrane oedema under the denture; 3<sup>rd</sup> type – granulated surface due to palpatory hyperplasia of the mucous membrane in the palate area. The most often is occurrence of the 2<sup>nd</sup> type of denture stomatitis [5].

More often than not we observe development of denture stomatitis of the maxilla [11]. The probably reason behind this is the greater area of oral mucosa covered by the complete denture. The surfaces covered by dentures are exposed to poorer flow of saliva and oxygen which creates favourable environment for the growth of microorganisms [12].

The organism has natural defence mechanisms against the development of oral infections. Unfortunately, it is not always sufficient for prevention of denture stomatitis. In their comprehensive overview, Le Bars et al. [13] analyse the mechanisms of organism's immune response to the impact of Candida species. As a result of evolution changes, the representatives of Candida albicans have acquired mechanisms for successfully overcoming host's

immunity [14]. Candida albicans in its capacity of commensals has developed resistance to host's immune defence on one hand while circumventing the mechanisms for recognizing its surface and on the other hand – via avoiding the process of macrophages phagocytosis [15].

In some circumstances, the increased development of microorganisms could become the reason not only for the occurrence of denture stomatitis, but of systematic diseases [16]. There have observed diseases of the gastro-intestinal tract, bacterial endocarditis, aspiration pneumonia, general respiratory infections, etc. [17]. Such a scenario usually occurs if there are concomitants that weaken the barrier function of natural defence mechanisms of the organism. As a result, the oral and general health status of patients deteriorates, hence their quality of life. This predefines problem's great social significance. That is why it is essential to know the factors that provoke the development of denture stomatitis and methods for their management.

**The purpose** of this review was to analyse the local factors that predispose towards the occurrence of denture stomatitis in complete dentures wearers, the contemporary prevention strategies and the role of the patients in their realization.

## LITERATURE REVIEW

A complex of local factors has direct impact on the occurrence of denture stomatitis. Some of them are related to the oral cavity conditions – saliva quantity and Ph level, oral mucosa integrity and hygiene status of oral cavity. Other factors are denture related - the surface characteristics of denture base material, hygiene status of dentures and period of their usage (age of dentures).

### Saliva quantity and Ph level inside the oral cavity

The role of saliva in the development of denture stomatitis is bi-directional. Saliva has cleaning effect towards the oral mucosa since it performs continuous washing of its

surface thus eliminating microorganisms, food residues, dead epithelial cells etc. The saliva takes part in the humoral immunity. It contains secretory immunoglobulins - IgAs and antimicrobial peptides that limit the proliferation of microorganisms and promote the balance maintenance in oral microflora [18]. On the other hand, some saliva proteins like mucines and statherins could serve as adhesive receptors for mannoproteins of fungal microorganisms of the *Candida* species [19]. It is established that when using complete dentures there is change in Ph of the saliva. It decreases and the created acidic environment favours the development of microorganisms. The proliferation of the *Candida* species, *Streptococcus mutans* and *Lactobacillus* increases in the case of low Ph level [11]. The colonisation of the species *Candida* inside the oral cavity could be 6 times more intensive in patients who use complete dentures [12].

The diet rich in carbohydrates could be additional risk factor that decreases the salivary flow and Ph of the oral cavity. This creates favourable conditions for the development of microorganisms and mostly representatives of the *Candida* species. In order to prevent the occurrence of denture stomatitis we need to perform control examinations regularly, especially in the case of patients with concomitant diseases as diabetes [20].

The therapy applied against chronic diseases with various medicines could also cause changes in the quantity and compounds of saliva. For example, wide-spectrum antibiotics and immune modulators could create favourable conditions for more extensive development of some fungal species [12]. In such cases, we need prevention with probiotics in order to maintain the balance of normal microflora.

A lot of medications such as corticosteroids, antihypertensive drugs, antidepressants etc cause xerostomia that also favours the development of fungal and bacterial infections.

### **Violation of oral mucosa integrity**

The mechanical injury of mucous membranes results in easier penetration of microorganisms and easier occurrence of infections onto the injured surface. The local inflammatory reaction caused by the injury could become more complicated due to bacterial or fungal infection [21]. Essential factor for prevention of oral mucosa integrity is the precise denture fitting to the denture bearing area, as well as its good retention and stability in view of function. Dentures of poor stability come out of place during chewing which could bring about injury of the mucous membrane. The same effect results from misbalanced occlusal contacts or unsuitable occlusal scheme that was chosen. The inaccurate teeth positioning, for example location of premolars and molars outside the residual ridge crest could result in biting the cheeks or lips and lesions of the oral mucosa.

### **Surface characteristics of denture base materials**

The surface characteristics of the denture base material could impact the level of microorganisms in the oral cavity. The conventional complete dentures are usually made of polymethacrylate [PMMA] with heat-activated polymerization. The well known characteristic of this material is its porosity that could become the reason for facilitated fixation of microorganisms. This could provoke the occurrence of denture stomatitis, especially in the presence of other harmful conditions, for example poor hygiene.

The hydrophobicity, low final hardness and high surface roughness are considered as unfavourable properties of the denture base materials that increased the adhesion of microorganisms [22].

One of the contemporary strategies for preventing denture stomatitis is the creation of modified denture base materials via which to overcome these negative effects. In a comprehensive review Mohd Farid et al. [23] summarize the opportunities for modifying the polymer denture base

materials in order to improve their biological qualities. The main ways are adding various modifying agents to the denture acrylic resin or the creation of coating for the denture base with antibacterial properties [22].

Many ingredients in the pattern of nanoparticles were tested as modifiers of denture base materials. It was researched the effect of adding **nanoparticles of:** Titanium Dioxide (TiO<sub>2</sub>) [24], silver nanoparticles [25,26], Nano graphene oxide (nGO) [27], nanodiamonds [28], SiO<sub>2</sub> micro nanoparticles [29], two-component nanocomposite that contains Boron Nitride and silver nanoparticles (Boron Nitride/Silver Nanocomposite) [30], etc. All these studies report that modified denture base materials have improved antimicrobial properties.

Other set of researches are directed towards analysis of the effect of adding different **inorganic ingredients:** N-dimethylaminoethyl methacrylate (DMAEMA) [31]; zinc dimethacrylate (ZDMA) [32], Thymoquinone [33], etc.

Other attempt for improving antimicrobial properties of denture materials is addition of various per cent of **Phytoncide** (1.25%, 2.5%, 3.75%, and 5%) to the monomer liquid. It was registered significant reduction of *Candida albicans* quantity and biofilm thickness underneath the dentures [34].

We have also analysed the effect of adding **food preservatives** to PMMA - sodium metabisulfite (0.5 %w/w) and potassium sorbate (1.0% w/w) [35]. We have examined the opportunity for processing denture resins with **probiotics** - *Lactobacillus rhamnosus* sp. and *Lactobacillus casei* sp. They manifest antifungal activity against representatives of *Blastoconidia* and *Candida albicans* [36]. It was found out that inorganic ingredients improve the antimicrobial properties of the material, without manifesting cytotoxicity.

We have also studied the effect of adding various **natural ingredients** to the denture resins with antifungal effect such as

Chitosan, Neem Powder and Henna [37,38,39]. These natural ingredients keep down the development of *Candida albicans* colonies on denture surface.

There are created a lot of modified denture base materials with antimicrobial properties that could be used as part of strategy for prevention of denture stomatitis. The changes in their mechanic and antibacterial properties vary depending on the used ingredient.

The main advantages inherent to modifications are improvement of final hardness, decrease of hydrophobicity and porosity which results in reduction of microorganisms' adhesion onto denture surface [24,25,27,29]. It was observed easier materials' polishing, which facilitates the maintenance of denture hygiene. However, it was established that higher concentrations of modifying agents' could deteriorates some materials' qualities such as decrease of flexural strength, increase of surface roughness and changes in colour [26,28,29]. We need of additional research in order to establish the optimal balance between the concentration of modifying agents, antimicrobial effectiveness and mechanical qualities of these materials.

The doctor of dental medicine should make an informed decision concerning the selection of the most suitable denture base material for each patient. It is him/her responsibility to inform the patients about the opportunity for preventing denture stomatitis by using dentures made of materials with antimicrobial properties.

### **Hygiene status of the oral cavity and the dentures**

The hygiene status plays key role in the maintenance of oral health. The regular and quality cleaning of removable dentures supports the elimination of bacterial biofilm in its capacity of factor for the occurrence of denture stomatitis, as well as of other related diseases. The unsatisfactory oral hygiene results in lowered Ph of oral cavity and causes changes in the microbiome and lowering its versatility. This facilitates the



growth of *Candida* species and other pathogens. Research that was performed among community-dwelling elderly patients shows that the irregular denture cleaning is frequently associated with occurrence of pneumonia [40].

Hygiene control of dentures is essential because of porosity of denture base material and its capacity to play the role of microorganisms' reservoir and contribute for the reinfection [41]. In order to achieve optimal effect, not only the denture surface but the oral mucosa should be included in the hygiene procedures.

The strategy for controlling the impact of this factor includes the application of effective methods, means and regime of maintaining the hygiene of dentures and oral cavity. To this end we have wide variety of options.

◆ **The methods for hygiene maintenance of dentures** could be divided into two main groups: chemical and mechanical.

↗ **The chemical methods for denture cleaning** are perceived as highly effective when it comes to preventing fungal and bacterial infections. Some authors classify the cleansing tablets in 3 main groups: alkaline peroxide; alkaline peroxide with enzyme; enzymes [41].

In a contemporary systematic review, we have analyzed the effectiveness of the various chemical agents concerning the reduction of *Candida* species quantity onto dentures [42]. Cleaning dentures with effervescent tablets that contain peroxide results in decreasing the total bacterial level and in particular *Streptococcus* species, yet it does not sufficiently influence *Candida* species [43]. The tablets based on alkaline peroxide reduce the colonies of *Candida albicans*, yet they do not fully eliminate them [44].

The best effect when it comes to eliminating *Candida albicans* is found with the use of sodium hypochlorite (NaOCl - gold standard solution). Nevertheless, it could not be used indefinitely since it could damage the denture surface [45].

Comparative analysis of various solutions for denture disinfection shows that diluted sodium hypochlorite, vinegar, chlorhexidine digluconate and fluconazole suppress bacterial growth with an effect similar to 1% sodium hypochlorite [45,46]. The enzymatic detergents and alkaline peroxide have poorer antibacterial effect. The solutions of 0.2% peracetic acid and 0.05% sodium salicylate are not effective against bacterial growth [45].

The application of propolis solution shows antimicrobial effect against *Streptococcus mutans* and *Candida albicans*, yet it is weaker than the one of alkaline peroxide. In the case of one-time application, it does not manifest immediate effect onto the microorganisms in denture biofilm [47].

Araujo et al. [48] research the effect of implementing 4 hygiene protocols for patients' complete dentures onto the development of denture stomatitis. We have compared the results from implementing cleansing with solutions of 0.25% sodium hypochlorite; 0.15% Triclosan; cleansing denture tablets; cleansing denture tablets in combination with gingival cleansing tablets. It was found out that all the four methods result in significant reduction of Gram-negative microorganisms and the formation of *Candida* species colonies. The authors conclude that the four protocols have comparable effectiveness.

We should bear in mind that the routine use of chemical cleansing ingredients could have unfavourable impact on the mechanical and aesthetical features of dentures base materials and of resilient liners in the long term. For example, in the case of resilient liners surface and volumetric modifications, discoloration could occur when using it for a period of 30 days [49]. Other negative effects of continuous use of chemical methods for PMMA denture cleansing are related to the increase of surface roughness and decrease of flexure strength. In order to avoid these undesired effects, patients must use chemical disinfectants in conformity with the guidelines issued by the producer

concerning the frequency and time of use during which dentures are in contact with the preparation [30].

Each and every chemical method for dentures' cleaning has its advantages and disadvantages. We could not differentiate a single one that is the best for denture stomatitis prevention.

↪ **The mechanical methods** include clean-up with a brush and water, with or without soap or paste, cleaning with microwaves and ultrasonic. Brushing is the simplest and widespread method for denture cleaning [51]. It is highly effective way to eliminate the biofilm, especially in combination with nonabrasive pastes. Cleaning the dentures with a brush whose hardness is high or use of abrasive pastes could increase the denture surface roughness.

↪ An alternative method for cleaning dentures could be the **irradiation with microwaves**. This method is proven as effective, easy for application and cheap. Its advantage is that it does not result in resistance towards microorganisms and does not cause changes of denture colour [52].

It was proven that microwave cleansing of dentures is method that ensures equivalent or even better results compared to other methods. An experimental study performed in vitro evaluates the effect of four different disinfection methods of complete dentures contaminated with *Candida albicans*. We have applied disinfection of dentures with Corega tablets, 2% glutaraldehyde, mechanical cleaning with a brush and microwave irradiation [53]. The methods with microwave irradiation [650 W, 3 min] and 2% glutaraldehyde demonstrate better effect compared to the other two methods.

Brondani and Siqueira [54] in a comprehensive review state that there is still no generally valid standardized protocol for disinfection of complete dentures via conventional microwave ovens that could guarantee optimal results and secure prevention of denture stomatitis. The microwave irradiation could cause

deterioration of dentures' mechanical properties, depending on the terms and conditions of performing it. The essential factors are the following: power of irradiation, whether dentures are submerged in water, the time during which they are exposed to microwave impact, as well as the frequency of implementing the method [54]. The most successful elimination of microorganism colonies is achieved if dentures are submerged in water. It was established that irradiation with 650 W microwaves for 3 minutes is effective against microorganisms attached to dentures for not more than 24 hours, whereas the extracellular polymer matrix has still not structured the biofilm [52,55].

Other research report that a power of 850 W and more and irradiation time of 6 min or longer could have harmful effect onto the mechanical property's denture base materials [56].

↪ We could refer to the mechanical methods **ultrasonic cleaning** of complete dentures. According to Kawasaki et al. [57] ultrasonic cleaning for 15 min removed 88.4% of *Candida* species from the denture base. In some authors' opinion, ultrasonic cleaning is less effective than the tablets for denture disinfection [58].

The versatility of methods for cleaning dentures is huge and there is no consensus on the most effective among them. According to the prevailing opinion, via combining various methods we could achieve better and uncompromising result, what is the suitable strategy for prevention of denture stomatitis, correspondingly [59].

◆ **The development of adequate hygiene habits** that ensure the maintenance of high hygiene level of dentures and oral cavity could be considered as an additional component in the strategy for prevention of denture stomatitis.

The dental literature contains significant number of researches that analyse patients' preferences concerning the methods of dentures cleaning. They show that the most often used methods are washing the

dentures with a brush and water or brush and toothpaste.

The prevailing numbers of patients clean their dentures with toothbrush and water. According to Kosuru et al. [60] this method is applied by 61.1% of patients; according to Saha et al. [61] – by 47%; according to Apratim [62] – by 31.3%.

According to research performed by Cinquanta et al. [63], the most often applied method is washing with toothbrush and toothpaste - by 29.2% of inquired persons whereas the recommended combined methods of mechanical cleaning and submerging the dentures in cleansing solutions is practiced by around 1/5 (21.1%) of all patients. According to Pavlova [64] approximately equal is the share of those who use only water and soap and the ones that use water, soap and brush, 29.09% and 32.73%, correspondingly.

What is essential to the prevention of denture stomatitis is also whether the patients use additional means for denture disinfection. Some researches show that significant part of patients rely for the hygiene of their dentures solely on washing. Only around 34.55% of patients are aware of the need to disinfect dentures and most of them – 23.63% use effervescent tablets [64]. Factor that is also essential for good oral hygiene is the **frequency of washing** and disinfecting dentures. The quantity of *Candida* species onto the surface of dentures is in correlation with the frequency of cleaning [65]. The various researches prove that most patients clean their dentures once daily. The per cent of these patients varies widely: 80.3% according to Kosuru et al. [60]; 52.5% according to Saha [51]; 44.7% - according to Apratim [62], 43.64% according to Pavlova [64].

Despite the great number of researches in recent years devoted to denture hygiene, there have still not suggested optimal regime for denture cleaning, which would ensure prevention of denture stomatitis occurrence.

It is interesting fact that during objective analysis of hygiene status of complete

dentures very often we establish mismatch between self-evaluation of patients and the actual results of the clinical evaluation. Kosuru et al. [60] report that almost 80% of the patients define the hygiene status of their dentures are good or satisfactory, yet the clinical evaluation shows that somewhat over half the dentures are of poor hygiene status.

◆ **Patients' awareness** for the maintenance of accurate hygiene is essential in order to achieve optimal results concerning the prevention of denture stomatitis. The contemporary researches show that the successful hygiene maintenance depends on the knowledge, hygiene habits and motivation of patients, and in this way the briefing manner – verbal or in writing is even more significant factor than the social-economic terms and conditions [64].

Cankaya et al. [66] established that 54.10% of the inquired persons who report they were not informed by their doctor about caring after the dentures have poor denture hygiene.

The responsibility for patients' awareness about the importance of dentures hygiene's maintenance belongs to the doctor of dental medicine. It is interesting to mention the results of an inquiry performed among doctors of dental medicine and professional dental hygienists. More than 10% of them communicate that they didn't provide their patients with initial recommendations on the manners to maintain hygiene of the dentures [67].

Additionally, the patients should be trained so that they could accurately define the hygiene status of their dentures and be informed about the negative consequences of neglecting this aspect [61,62]. The active attitude demonstrated by the doctor of dental medicine in the procurement of information for the patients could result in significant improvement of hygiene habits and be useful element of the complex approach towards prevention of denture stomatitis. The application of modern digital

technologies to this end could assist in achieving remote monitoring and effective training of patients. A research performed during the period of COVID19 pandemics demonstrated that after online training via video presentations, most patients start washing their dentures three or at least two times daily [68].

### Period of using the complete dentures

Another factor that could impact the occurrence of denture stomatitis is the term of using the complete dentures. As the time passes by, changes occur due to the continuing atrophy of alveolar ridges. On the other hand, changes occur in the denture construction as a result of its use [69]. Under the impact of these changes, precisely elaborated dentures could lose their good functional properties. The violated conformity with denture bearing area could result in injuries of the underlying tissues. Unfortunately, more than half of the patients use their removable dentures exceeding the generally accepted periods of functional fitness. The per cent of patients who use their dentures for more than 5 years according to Pavlova [70] is 54.17%, according to De Castellucci Barbosa et al. [71] it goes up to 78% of all the inquired persons.

We have analysed the connection between the period of using the complete dentures and the condition of mucous membrane of

denture field in three groups of patients – the ones that have used their complete dentures for a period of 1 to 5 years, from 5 to 10 years and over 10 years. Injured oral mucosa was observed in 11.82% of the persons of first group, in 38,57% of the second group and in 66.67% of the third group. The need of treatment based on clinical evaluation shows that 40% of dentures aged 5 and 80% of the ones aged 10 should be replaced with new ones [70].

Patients underestimate the need of regular control examinations for the evaluation of their complete dentures' condition, which is prerequisite for the deterioration of their oral health and worsening the problems as the time passes by [67].

The good patient's awareness about the impact of the local factors and options for their management could limit the frequency of denture stomatitis. Active communication with patients as part of prevention strategy is of great importance.

The doctor of dental medicine should discuss with the patients the main issues concerning occurrence of denture stomatitis (Figure 1). The dentist should take part in tuition of the patients for: implementation of the hygiene procedures; self-assessment of dentures' hygiene status; recognition of the symptoms of denture stomatitis; recognition of deteriorated denture fitness and related symptoms in oral cavity.

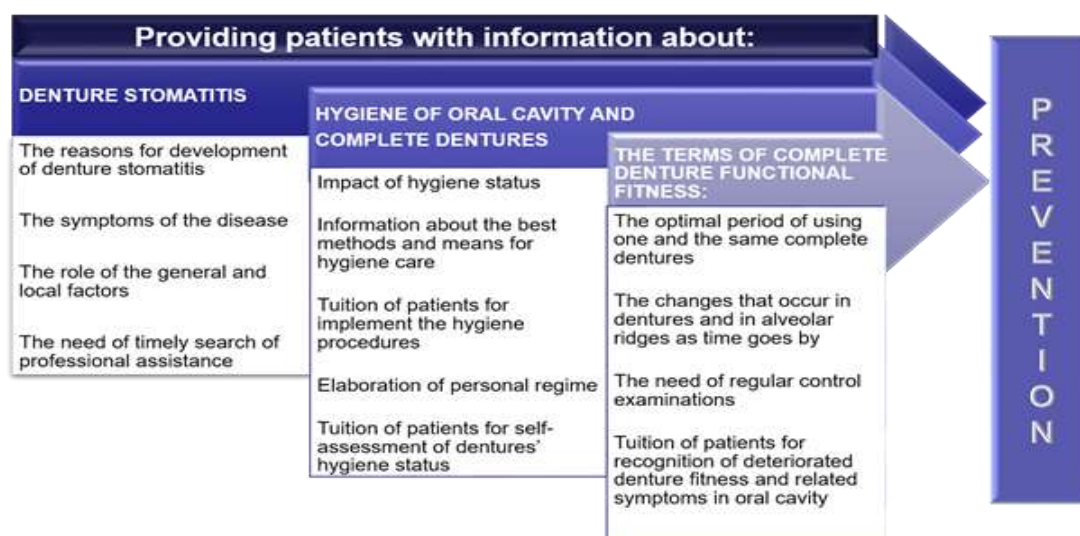


Figure 1. Optional strategy for information of patients about denture stomatitis and its prevention



There is need of future scientific researches directed at the creation of algorithm for evaluation of all factors conducive to denture stomatitis for each and every patient individually. Underestimating whatever general or local factor could result in clinical manifestation of the disease with all the unfavourable consequences from this for the oral and general health of patient. In order to avoid development of this negative scenario, application of complex strategy for prevention of denture stomatitis that includes active participation of the patient can be useful.

## CONCLUSION

The analysis of dental literature gives us grounds to conclude that we have clarified the role of local factors for the development of denture stomatitis. There are available different strategies via which we can change positively the influence of each and every factor. Successful prevention of denture stomatitis could be achieved with the application of complex approach that includes evaluation of all the general and local factors and implementation of multi-component strategy for the management of their impact. The active collaboration with patient is essential for successful prevention of the denture stomatitis.

## Declaration by Authors

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## REFERENCES

1. Lamont RJ, Koo H, Hajishengallis G. The oral microbiota: dynamic communities and host interactions. *Nat Rev Microbiol* 2018; 16(12):745-759.
2. Schweigel H, Wicht M, Schwendicke F. Salivary and pellicle proteome: a datamining analysis. *Sci Rep* 2016; 6:38882. Available from: <http://ncbi.nlm.nih.gov/pmc/articles/PMC5155218/>
3. Bowen WH, Burne RA, Wu H et al. Oral biofilms: pathogens, matrix and polymicrobial interactions in microenvironments. *Trends Microbiol.* 2019; 26(3):229-242.
4. Idris A, Hasnain SZ, Huat LZ et al. Human diseases, immunity and the oral microbiota - insights gained from metagenomic studies. *Oral Sci Int.* 2017; 14(2):27-32.
5. Hannah VE, O'Donnell L, Robertson D et al. Denture stomatitis: causes, cures and prevention. *Prim Dent J.* 2017; 6(4):46-51.
6. Gendreau L, Loewy ZG. Epidemiology and etiology of denture stomatitis. *J Prosthodont.* 2011; 20(4):251-260.
7. Shi B, Wu T, McLean J et al. The denture-associated oral microbiome in health and stomatitis. *mSphere.* 2016; 1:e00215-e00216.
8. Zhang Y, Wang X, Li H et al. Human oral microbiota and its modulation for oral health. *BioMed Pharmacother.* 2018; 99:883-893.
9. O Toole G, Kaplan HB, Kolter R. Biofilm formation as microbial development. *Annu Rev Microbiol.* 2000; 54:49-79.
10. Newton AV. Denture sore mouth. A possible etiology. *Br Dent J.* 1962; 112: 357-360.
11. Dandekeri S, Prasad K, Shetty M et al. Occurrence of streptococcus and Candida species and salivary Ph in patients wearing complete denture. *Int J Health Rehabil Sci.* 2013; 2(4):198-203.
12. Chopde N, Jawale B, Pharande A et al. Microbial colonization and their relation with potential cofactors in patients with denture stomatitis. *J Contemp Dent Pract.* 2012; 13(4):456-459.
13. Le Bars P, Kouadio AA, Bandiaky ON et al. Host's Immunity and Candida Species Associated with Denture Stomatitis: A Narrative Review. *Microorganisms* 2022; 10(7):1437.
14. Singh DK, Tóth R, Gácsér A. Mechanisms of pathogenic candida species to evade the host complement attack. *Front Cell Infect Microbiol.* 2020; 10:94. Available from: [www.ncbi.nlm.nih.gov/pmc/articles/PMC7082757/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC7082757/)
15. Cruz PC, Andrade IM, Peracini A et al. The effectiveness of chemical denture cleansers and ultrasonic device in biofilm removal from complete dentures. *J Appl Oral Sci.* 2011; 19(6):668-673.

16. Peng X, Cheng L, You Y et al. Oral microbiota in human systematic diseases. *Int J Oral Sci.* 2022; 14(1):14.
17. Li X, Kolltveit KM, Tronstad L et al. Systemic diseases caused by oral infection. *Clin Microbiol Rev.* 2000; 13(4):547-558.
18. Li Y, Jin L, Chen T. The effects of secretory IgA in the mucosal immune system. *BioMed ResInt.*2020;3:2032057. Available from: [www.hindawi.com/journals/bmri/2020/2032057/](http://www.hindawi.com/journals/bmri/2020/2032057/)
19. Hoshing C, Dixit S, Mootha A et al. Role of *Candida albicans* in denture stomatitis. *J Indian Acad Oral Med Radiol.* 2011; 23:617-619.
20. Contaldo M, Romano A, Mascitti M et al. Association between denture stomatitis, candida species and diabetic status. *J Biol Regul Homeost Agents.* 2019; 33(3 Suppl. 1):35-41.
21. Nikou SA, Kichik N, Brown R et al. *Candida albicans* interactions with mucosal surfaces during health and disease. *Pathogens.* 2019; 8(2):53. Available from: [www.mdpi.com/2076-0817/8/2/53](http://www.mdpi.com/2076-0817/8/2/53)
22. Lazarin AA, Zamperini CA, Vergani CE et al. *Candida albicans* adherence to an acrylic resin modified by experimental photopolymerised coatings: an in vitro study. *Gerodontology.* 2014; 31(1):25-33.
23. Mohd Farid DA; Zahari NH, Said Z et al. Modification of polymer-based dentures on biological properties: Current update, status, and findings. *Int J Mol Sci.* 2022; 23(18): 10426.
24. Alrahlah A, Fouad H, Hashem M et al. Titanium oxide (TiO<sub>2</sub>)/polymethylmethacrylate (PMMA) denture base nanocomposites: Mechanical, viscoelastic and antibacterial behavior. *Materials.* 2018; 11(7):1096.
25. De Matteis V, Cascione M, Toma CC et al. Silver Nanoparticles addition in Poly (Methyl Methacrylate) dental matrix: Topographic and antimycotic studies. *Int J Mol Sci.* 2019; 20(19):4691.
26. Gligorijević N, Mihajlov-Krstev T, Kostić M et al. antimicrobial properties of Silver-modified denture base resins. *Nanomaterials.* 2022; 12(14):2453.
27. Lee JH, Jo JK; Kim DA et al. Nano-graphene oxide incorporated into PMMA resin to prevent microbial adhesion. *Dent Mater.* 2018; 34(4):e63–e72.
28. Fouda SM, Gad MM, Ellakany P et al. The effect of Nanodiamonds on *Candida albicans* adhesion and surface characteristics of PMMA denture base material - an in vitro study. *J Appl Oral Sci.* 2019; 27:e20180779.
29. Alzayyat ST, Almutiri GA, Aljandan JK et al. Antifungal efficacy and physical properties of Poly (methylmethacrylate) denture base material reinforced with SiO<sub>2</sub> Nanoparticles. *J Prosthodont.* 2021; 30(6):500-508.
30. Li M, Wang S, Li R et al. The mechanical and antibacterial properties of Boron Nitride/Silver Nanocomposite Enhanced Polymethyl Methacrylate Resin for application in oral denture bases. *Biomimetics.* 2022; 7(3):138.
31. Mirizadeh A, Atai M, Ebrahimi S. Fabrication of denture base materials with antimicrobial properties. *J Prosthet Dent.* 2018; 119(2):292-298.
32. A J, Ding N, Zhang Z. Mechanical and antibacterial properties of polymethyl methacrylate modified with zinc dimethacrylate. *J Prosthet Dent.* 2022; 128(1):1001-1008.
33. Gad MM, Al-Thobity AM, Fouda SM et al. Flexural and surface properties of PMMA denture base material modified with Thymoquinone as an antifungal agent. *J Prosthodont.* 2020; 29(3):243-250.
34. Lee MJ, Kim MJ, Oh SH et al. Novel dental poly (methyl methacrylate) containing phytoncide for antifungal effect and inhibition of oral multispecies biofilm. *Materials* 2020; 13(2):371.
35. Ratanajanchai M, Kanchanasavita W, Suputtamongkol K et al. Heat-cured poly (methyl methacrylate) resin incorporated with different food preservatives as an antimicrobial denture base material. *J Dent Sci.* 2021; 16(2):706-712.
36. Song YG, Lee SH. Inhibitory effects of *Lactobacillus rhamnosus* and *Lactobacillus casei* on *Candida* biofilm of denture surface. *Arch Oral Biol.* 2017; 76:1-6.
37. Fakhri E, Eslami H, Maroufi P et al. Chitosan biomaterials application in dentistry. *Int J Biol Macromol.* 2020; 162:956-974.
38. Hamid SK, Al-Dubayan AH, Al-Awami H et al. In vitro assessment of the antifungal effects of neem powder added to polymethyl methacrylate denture base material. *J Clin Exp Dent.* 2019; 11(2):70-178.

39. Gad M, Rahoma A, Nawasra A et al. Influence of henna addition on the flexural strength of acrylic denture base material: An in vitro study. *Al-Azhar Dent J Girls* 2018; 5(3):277-2783.
40. Kusama T, Aida J, Yamamoto T et al. Infrequent denture cleaning increased the risk of pneumonia among community-dwelling older adults: A population-based cross-sectional study. *Sci Rep.* 2019; 9(1):13734.
41. Ferreira MA, Pereira-Cenci T, Rodrigues de Vasconcelos LM et al. Efficacy of denture cleansers on denture liners contaminated with *Candida* species. *Clin Oral Investig.* 2009; 13(2):237-242.
42. Rocha GR, Duarte TN, Corrêa GDO et al. Chemical cleaning methods for prostheses colonized by *Candida* spp.: A systematic review. *J Prosthet Dent.* 2020; 124(6):653-658.
43. De Lucena-Ferreira SC, Filho APR, da Silva WJ et al. Influence of daily immersion in denture cleanser on multispecies biofilm. *Clin Oral Investig.* 2014; 18(9):2179-2185.
44. Uludamar A, Ozkan YK, Kadir T et al. In vivo efficacy of alkaline peroxide tablets and mouthwashes on *Candida albicans* in patients with denture stomatitis. *J Appl Oral Sci.* 2010; 18(3):291-296.
45. Pires CW, Fraga S, Beck AC, et al. Chemical methods for cleaning conventional dentures: What is the best antimicrobial option? An in vitro study. *Oral Health Prev Dent.* 2017; 15(1):73-77.
46. Salim N, Moore C, Silikas N et al. Candidacidal effect of fluconazole and chlorhexidine released from acrylic polymer. *J Antimicrob Chemother.* 2013; 68(3):587-592.
47. De Souza RF, Silva-Lovato CH, De Arruda CN et al. Efficacy of a propolis solution for cleaning complete dentures. *Am J Dent.* 2019; 32(6):306-310.
48. Araujo CB, Ribeiro AB, Fortes CV et al. Effect of local hygiene protocols on denture-related stomatitis, biofilm, microbial load, and odor: A randomized controlled trial. *J Prosthet Dent.* 2022; 128(4):664-673.
49. Huh JB, Lim Y, Youn HI et al. Effect of denture cleansers on *Candida albicans* biofilm formation over resilient liners. *J Adv Prosthodont.* 2014; 6(2):109-114.
50. Porwal A, Khandelwal M, Punia V et al. Effect of denture cleansers on color stability, surface roughness, and hardness of different denture base resins. *J Indian Prosthodont Soc.* 2017; 17(1):61-67.
51. Aoun G., Gerges E. Assessment of hygiene habits in acrylic denture wearers: a Cross-sectional study. *Mater Sociomed.* 2017; 29(3):216-218.
52. Dantas AM, Consani RLX, Sardi JCO et al. Biofilm formation in denture base acrylic resins and disinfection method using microwave. *J Res Pract Dent.* 2014; 2014:112424. Available from: <http://ibimapublishing.com/articles/DENT/2014/112424/>
53. Aslanimehr M, Mojarad N, Ranjbar S et al. In vitro comparison of the effects of microwave irradiation and chemical and mechanical methods on the disinfection of complete dentures contaminated with *Candida albicans*. *Dent Res J.* 2018; 15(5):340-346.
54. Brondani MA, Siqueira AR. A critical review of protocols for conventional microwave oven use for denture disinfection. *Comm Dent Health.* 2018; 35(4):228-234.
55. Senna PM, Silva WJ, Del Bel Cury AA. Denture disinfection by microwave energy: influence of *Candida albicans* biofilm. *Gerodontology.* 2012; 29(2):186-191.
56. Brondani MA, Samim F, Feng H. A conventional microwave oven for denture cleaning: a critical review. *Gerodontology.* 2012; 29(2):6-15.
57. Kawasaki K, Kamikawa Y, Sugihara K. In vitro and in vivo removal of oral *Candida* from the denture base. *Gerodontology.* 2016; 33(2):247-252.
58. De Andrade IM, Cruz PC, Da Silva CHL et al. Effervescent tablets and ultrasonic devices against *Candida* and mutans streptococci in denture biofilm. *Gerodontology.* 2011; 28(4):264-270.
59. Baba Y, Sato Y, Owada G et al. Effectiveness of a combination denture-cleaning method versus a mechanical method: comparison of denture cleanliness, patient satisfaction, and oral health-related quality of life. *J Prosthodont Res.* 2018; 62(3):353-358.
60. Kosuru KV, Devi G., Grandhi V et al. Denture care practices and perceived denture status among complete denture

- wearers. *J Int Soc Prevent Communit Dent.* 2017; 7(1):41-45.
61. Saha A, Dutta S, Varghese RK et al. A survey assessing modes of maintaining denture hygiene among elderly patients. *J Int Soc Prevent Community Dent.* 2014; 4(3):145-148.
62. Apratim A, Shah SS, Sinha M et al. Denture hygiene habits among elderly patients wearing complete dentures. *J Contemp Dent Pract.* 2013; 14(6):1161-1164.
63. Cinquanta L, Varoni EM, Barbieri C et al. Patient attitude and habits regarding removable denture home hygiene and correlation with prosthesis cleanliness: A cross-sectional study of elderly Italians. *J Prosthet Dent.* 2021; 125(5): 772.e1-772.e7.
64. Pavlova Zh. Influence of subjective factors over hygiene habits of complete denture wearers. *Int J Adv Res.* 2023; 11(1):899-906.
65. Ramage G., O'Donnell L, Sherry L et al. Impact of frequency of denture cleaning on microbial and clinical parameters – a bench to chairside approach. *J Oral Microbiol.* 2019; 11(1):1538437.
66. Cankaya ZT, Yurdakos A, Kalabay PG. The association between denture care and oral hygiene habits, oral hygiene knowledge and periodontal status of geriatric patients wearing removable partial dentures. *Eur Oral Res.* 2020; 54(1):9-15.
67. Axe AS, Varghese R, Bosma ML et al. Dental health professional recommendation and consumer habits in denture cleansing. *J Prosthet Dent.* 2016; 115(2):183-188.
68. Dwivedi H, Paul N, Banerjee KL et al. Denture hygiene awareness, attitude and practice among complete denture wearers during COVID-19 lockdown Pandemic: A questionnaire-based survey. *J Pharm. Bioallied Sci.* 2021; 13(Suppl2): S1119-S1123.
69. Subramanian D, Govindarajulu RT, Narayanan V. Comparison of expectation and satisfaction among new and existing denture wearers and correlation of duration of previous denture-wearing experience to satisfaction in completely edentulous patients: A pilot study. *J Indian Prosthodont Soc.* 2019; 19(4):324-331.
70. Pavlova, Zh. Terms of use of complete dentures and life quality of patients. *Int J Med. Dent.* 2022; 26(3):476-483.
71. De Castellucci Barbosa L, Ferreira MR, De Carvalho Calabrich CF et al. Edentulous patients' knowledge of dental hygiene and care of prostheses. *Gerodontology.* 2008; 25(2):99-106.

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