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Review Article

Systemic Conditions and Associations with Dental Prostheses

Butler Craig J, Mundey Shakeya, Cherry-Peppers Gail*, Fryer Cheryl E, Jackson Andrea D, Woods Dexter, Sonnier Jezelle, Mercer Janis, Slade Lisa, Robinson-Warner Gillian, Noel Kenson E, Salter Reginald, Alayssami Mazin, Boxill Shannon, Lotlikar Priti, Graves Yolanda, Peppers Gretchen, Thompson Jelani, Pasham Sameera, Cooper Ciara and Miller Dejenee

Howard University Research Committee, Faculty and Affiliates, and Research Committee Students, USA

***Corresponding Author:** Cherry-Peppers Gail, Howard University Research Committee, Faculty and Affiliates, and Research Committee Students, USA.

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Abstract

The incidence of debilitating conditions such as diabetes, cardiovascular disease, and risk factors such as the use of tobacco products continues to climb. The impact and detrimental role of these systemic conditions present a challenge in the maintenance of oral health after loss of teeth. Long-lasting systemic diseases may persist and worsen over time, and can result in deterioration of oral function, and poor outcomes for those patients who wear full and partial dentures. The need for prosthetic devices will continue to increase as the average life expectancy age increases. There is a great need to improve access and frequency of prosthetic dental visits. Incorporating routine oral health assessments and regular denture maintenance visits may improve overall health and successful patient outcomes.

Keywords: Oral Health; Diabetes; Inflammation; Tobacco Use; Cardiovascular Disease; Dentures

Introduction

Dentate and partially dentate individuals commonly lose teeth as the result of periodontal diseases and caries. Systemic health such as diabetes and cardiovascular diseases also play a role in tooth loss [1]. Diabetes continues to grow as a national health priority. Recent estimates suggest that diabetes affects more than 40.1 million Americans, with 90% to 95% of cases representing Type 2 diabetes. Risk factors such as tobacco use in diabetic patients, also adversely affects the course of many co-morbidities [2]. The burden of multiple systemic diseases [1], risk factors and age-related vulnerabilities support the need for follow-up and improved accessibility to dental care.

Diabetes and factors that may alter denture success

Studies have suggested that diabetes is positively associated with periodontitis, caries, and the number of missing teeth. Accordingly, a higher number of patients with diabetes may require a dental prosthesis to replace missing teeth. The masticatory performance of the dental prosthesis may also be altered as the systemic process worsens [3].

Diabetes is an important modifier of oral rehabilitation outcomes, and additionally in implant therapy, but it is not an absolute contraindication to dentures or implants, but the tissue environment becomes less forgiving as glycemic control worsens [4]. The most consistent message across the accessible studies is that glycemic control is central [1]. Well-controlled diabetes is generally associated with acceptable implant and denture-wearing outcomes. Poorly controlled diabetes is associated with worse peri-implant tissue health, greater inflammatory burden, and less favorable supporting-structure findings [4,5]. Diabetes and especially the level of metabolic control, influences healing, osseointegration, inflammation, maintenance, long-term tissue stability of denture-wearing and implants [3].

Diabetic patients may undergo a metabolic decline in multiple systems, including changes in the oral cavity. Heightened activation of immune systems, local adipose inflammation and the secretion of a plethora of pro-inflammatory adipokines from visceral adipose tissues is indicated in metabolic disease [3]. Maintenance becomes especially important. Control of plaque and mucosal inflammation, attention to bleeding, and periodic monitoring of peri-implant tissues are factors of great significance. A patient with acceptable radiographic bone levels may still have a less stable biologic environment if inflammation is not well controlled [1,3,4]. For denture patients, the literature supports awareness that denture wear may signal a more complex oral and systemic history. In addition to being edentulous or partially edentulous, other debilitating conditions such as the presence of vascular disease, prior periodontal destruction, multiple medications, and other systemic modifiers that influence comfort, function, and ongoing oral maintenance may occur [1,6].

Ueta., *et al*. found that patients with diabetes had a high number of pulpal and periodontal infections and that diabetes was a predisposing condition for endodontic infections [7]. Animal studies in diabetic rats given a sucrose solution resulted in very large peri-radicular lesions [1,8].

Chronic hyperglycemia is one of the most frequent effects of diabetes and another major underlying cause for associated complications. Patients with diabetes may experience severe lesions affecting eye function, peripheral nerves, and blood vessels [1,3]. Significant health risks to major organ systems may occur within the human body, including atherosclerotic vascular disease, neuropathy, or peripheral artery disease, and in severe situations amputations, loss of kidney function and progression of multi-organ complications. Diabetes affects several functions of the immune system, making the diabetic patient more vulnerable to chronic inflammation, progressive tissue damage, and reduction of tissue repair [1,3]. Chronicity of inflammation presents the strongest plausibility for detrimental effects of inflammatory events that could also link periodontal disease and other oral diseases to individuals who wear dentures. Diabetes and tobacco users are threats to systemic health and oral health [1,3].

Diabetic glucooxidative stress impairs the healing response and disrupts the flow of overlapping healing phases. In addition to healing impairment, other factors include non-healing wounds which are a major predisposing factor or entry point for infections [3,9]. A microbiota biofilm comprises symbiotic bacteria, yeast and fungal loads and can silently spread, amplifying the underlying healing deficit [10].

Cardiovascular disease and its association to denture wearing

The reviewed literature suggests that cardiovascular disease is linked more strongly to severe tooth loss, edentulism, denture use, and peri-implantitis [5,10]. Large observational studies show that denture use and complete edentulism are more common in people with cardiovascular disease. This suggests that cardiovascular patients often present with a heavy overall oral disease burden and particularly increases in caries and periodontal disease [1,10]. Denture use in this population may reflect long-standing oral deterioration, prior periodontal destruction, shared inflammatory risk factors, and accumulated comorbidity rather than a single isolated prosthodontic problem [6]. Patients with cardiovascular disease who wear dentures are often also diagnosed with systemic vascular disease, medication burden, inflammatory risk, and age-related vulnerability that may influence oral rehabilitation [6].

One NHANES denture study found that denture use remained significantly associated with cardiovascular disease even after adjustment for multiple confounders, including smoking, alcohol, body mass index, hypertension, diabetes, hyperlipidemia, and gum problems (periodontal disease) [11]. Findings from another NHANES analysis on complete edentulism showed a similar overall

direction. It was noted that adults with myocardial infarction, coronary heart disease, congestive heart failure, or stroke were more likely to be completely edentulous than adults without these conditions [1,6,11]. These studies did not directly measure denture-bearing ridge resorption, mucosal tolerance, or structural changes in the supporting tissues under removable prostheses. However, they do show that the clinical state that usually leads to wearing dentures is strongly intertwined with cardiovascular disease [6,11].

Other associations include studies that show that cardiovascular disease alone may not automatically compromise whether an implant remains in place or whether radiographic bone loss becomes obviously worse over time [12]. Additionally, less favorable peri-implant tissue parameters and more bleeding in cardiovascular patients were common [12]. The soft tissues may show more inflammation, more plaque-related problems, and more bleeding tendencies [3,12]. That pattern supports the view that cardiovascular disease may influence implant rehabilitation through biologic tissue quality and inflammatory response rather than through immediate implant loss [12]. The presence of cardiovascular disease increased the risk of peri-implantitis [13]. Peri-implantitis is not simply a superficial inflammatory change of the implant-supporting apparatus. It involves soft-tissue inflammation and progressive loss of supporting bone [3]. When cardiovascular disease is associated with a higher prevalence of peri-implantitis, cardiovascular patients may be more vulnerable to adverse tissue responses around implants even if overall survival remains good [13].

Oral dysbiosis, linked to systemic conditions like obesity, diabetes, and cardiovascular disease, is common in inflammatory oral diseases such as periodontitis and denture stomatitis, disrupting original oral microbiota [13]. This imbalance may lead to transient bacteremia and systemic inflammation, contributing to cardiovascular disease development [3,13]. Tooth loss reduces salivary microbiome diversity, and denture use in cardiovascular disease patients may be linked to decreased life expectancy compared to dentate individuals. The findings suggest that tooth loss, denture use, and oral microbiota dysbiosis are unconventional risk factors for cardiovascular disease progression [1,10].

Tobacco use and denture wearing

Smokeless tobacco products and e-cigarettes may deliver substantial doses of nicotine along with powerful cancer-causing chemicals [14,15]. Studies reporting nicotine plasma concentrations during e-cigarette use may show deviating results depending on the device. E-cigarettes and smokeless tobacco are offered with a great variety of over 4,000 estimated assorted flavors and toxins [15]. E-cigarettes have a significant amount of nicotine based on use, which can be dangerous. Nicotine is one of the addictive components of e-cigarette use, smokeless tobacco products and in cigarettes [16].

Absorption of nicotine across biological membranes is highly pH dependent [16]. Free nicotine (unionized and pH above 6.5) is readily absorbed into biological tissues [17], and well absorbed through the mouth and buccal membranes, and underneath dentures [16]. Smokeless tobacco users and those who smoke cigarettes have comparable levels of nicotine in the blood [16]. Nicotine found in smokeless tobacco and cigarettes, is absorbed through the oral cavity tissues directly continues into the blood, where it goes to the brain [18]. Even after the tobacco is removed from the mouth, nicotine continues to be absorbed into the bloodstream [17]. Orally absorbed nicotine stays in the blood longer for users of smokeless tobacco than for cigarette smokers and is easily absorbed through the oral mucosal lining [16]. Approximately twice as much nicotine was absorbed per dose of smokeless tobacco than cigarettes (4 mg vs. 2 mg) [16,19].

Oral tissue alterations occur due to tobacco use, especially along the oral mucosal areas where the tobacco is placed. Zhang., *et al*. showed that inflammatory responses and osteoclastogenesis are commonly involved in the development of periodontitis [20]. Animal studies revealed that the periodontium is aggravated by nicotine, causing ischemia and inflammation. Nicotine, the addictive component in tobacco products, is associated with inflammatory mediators which aggravate oral mucosal tissues [20,21].

The association of periodontitis was found to be statistically significant with smoking cigarettes, diabetes, hypertension, and age. Higher age predicted greater incidence of periodontal disease. The most common risk factors attributed to periodontal diseases are tobacco use, diabetes, pathogenic bacteria, and tooth deposits [22]. Fouad., *et al*. investigated treatment outcomes in root canal therapy and found that patients with diabetes have a reduced likelihood of successful treatment in cases with peri-radicular lesions [23]. High prevalence of periodontitis occurs after long-term, heavy use of tobacco products [20]. These systemic conditions may lead to

loss of teeth, and many alterations for those who wear dentures may need to be considered [12,20].

Daily e-cigarette use has been associated with poor oral health [24], including increased risk of periodontitis and caries. Harmful aerosol constituents can contribute to oxidative stress, imbalances in DNA damage and repair, increased inflammation and, altered host-microbial interactions, ultimately promoting oral inflammatory and pre-malignant lesions, and other potential adverse effects in oral and systemic health [25]. Denture wearers who vape and use smokeless tobacco are at great risk for tooth loss, periimplantitis and inflammatory conditions such as hyperplasia and smokers' stomatitis [26].

Oral mucosal lesions that may result from tobacco use include leukoplakia, erythroplakia, pre-cancerous lesions of the oral cavity and pharynx, oral diseases of the gingival and periodontal tissues may involve inflammatory processes [16,27]. Higher risk of denture stomatitis occurs, in addition to denture hyperplasia, frictional keratosis, increased melanin pigmentation and traumatic ulcers in use of tobacco and in those who wear dentures [28]. Smokeless tobacco use is again popular in the new forms of snuff and snus. After long-term use, snuff-dippers lesions, and other inflammatory-related lesions such as sores may occur [16]. Snuff submucosal deposits may lead to dental caries [16], and other factors enhance the periodontal and carious process. Diabetic patients who use tobacco products are more likely to experience masticatory inefficiencies.

One study found that denture stomatitis was approximately 2 times more prevalent in current cigarette smokers when compared to non-cigarette smokers and that denture stomatitis significantly increased in cigarette smokers [29]. The association was thought to be in relationship to increasing *Candida* carriage, as cigarettes increase epithelial thickness and changes functional activity of the keratinocytes which leads to *Candida* colonization [16,29].

Conclusion

Efforts are needed to assess the public health impact and dangers associated with diabetes, cardiovascular disease, the use of tobacco products, and pro-inflammatory oral conditions. Increases in caries, periodontal disease and the overall oral disease burden exists due to inflammatory responses in patients with diabetes and cardiovascular disease. There is a continued need to evaluate cytological and morphologic alterations of oral mucosal tissues. Numerous epithelial layer cells and oral mucosal membranes are altered by chemicals and constituents in cigarette smoking; e-cigarette use and in the use of tobacco products . Significant inflammatory processes and health risks to major organ systems and masticatory systems break down teeth and jaw-related components, thus diminishing oral conditions. Regular recall and maintenance of the remaining teeth and surrounding bone is critical to long-term successful denture wearing and implant stability. Patient education and clear explanations of possible outcomes must be shared with patients. Collaboration and coordination with the patients' medical specialists can help shape better outcomes.

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