

Aging and the periodontium

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Abstract

The geriatric population has been growing fast over the last decades in Brazil and all over the world, changing demographics. Additionally, increased knowledge and the advances of modern dentistry have led the old population to retain more natural teeth, needing specialized dental services for a longer time. Changes in biochemical and physiological processes occur with aging in all body tissues, including the periodontium. The association between periodontal and systemic diseases has also been widely discussed, suggesting the need of a multidisciplinary care, especially in older adults, who are frequently affected by chronic systemic conditions and multiple drug therapy. These features lead to a highly complex management of the geriatric population, challenging the dental care providers. The aim of this study is to review the age-related changes and the consequences of other factors, such as systemic diseases and drugs, on the periodontium of aged patients.

Keywords: aging, periodontium, disease.

Introduction

Population of older adults has been growing in a non preceding rhythm all over the world. In Brazil, individuals aged 60 to 64 years are the most prevalent within the elderly, representing 30% of this population. However, the most significant increase has been observed for individuals over 80 years, whose number increased from 560 thousand people in 1980 to almost 2 million people in 2006¹.

Nowadays, more people retain their natural teeth throughout life. Comparison of five nursing home populations from 1988 to 2004 indicates improvement in dental status among the elderly population. The rate of edentulism decreased from 71 to 43% and the percentage of subjects retaining 20-28 teeth increased from 3 to 23%. Moreover, the mean number of teeth for each participant was 3.1 in 1988 compared with 8.4 in 2004².

With the longer retention of teeth, older adults remain at risk for periodontal disease. In a population composed by 89 individuals, being 87% over 80 years of age, none presented healthy periodontium. All subjects presented bleeding on probing, 93% presented calculus and 65% had periodontal pockets of 4 mm depth or more². Gingival recession and loss of periodontal attachment are also very prevalent among the older adults. Fifty-six to 92% of individuals aged 45 years and older present periodontal attachment loss of 3 mm or more in at least one oral site³. This condition worsens with time⁴, most likely because of the increase in gingival recession rather than probing depth⁵. In spite of the high incidence of moderate attachment loss in middle-aged and geriatric subjects, severe loss is confined to a minority and is present in only a few sites. Generalized severe attachment loss is experienced by approximately one fifth of older individuals³.

This damage to the periodontal tissues may be due to various changes on biochemical, immunological and physiological processes during aging³. However, it is not known whether and to what extent the changes are due to the aging process or consequences of other factors, such as systemic diseases, medications or

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social and environmental modifications⁶.

This paper reviews the changes in the periodontal tissues due to the aging process, systemic medications and medical conditions, in order to guide the clinician to a better multidisciplinary understanding, which is imperative for the treatment of older adults.

Age-related changes in periodontal tissues

Morphological alterations

The thinning and decreasing in the keratinization of the gingival epithelium may occur with aging and may indicate an increase in tissue permeability and a decrease in its resistance to infection and trauma⁷. Moreover, flattening of the epithelial invaginations toward the conjunctive tissue⁷, a high vacuolization of interstitial spaces and the invasion of fat cells are also observed with aging⁸. However, there is no consensus in the literature regarding this issue.

The apical migration of the junctional epithelium, with consequent gingival recession, has been discussed. Although such a migration is associated with aging, the loss of insertion caused by aging alone may not seem to have clinical significance³. Gingival recession progression may occur due to several factors, such as passive eruption caused by physiological wear of teeth, a consequence of anatomically thin tissues and toothbrushing trauma. Apparently, gingival recession is not an avoidable physiological process caused by aging, but a cumulative and progressive effect from periodontal disease or trauma over time⁷.

There is a reduction in the number of total cells⁸⁻⁹ in the connective tissue and a consequent reduction in collagen synthesis. However, a higher collagen amount can be found due to an increase in the conversion of soluble collagen to insoluble collagen, as well as to an increase in the denaturation temperature and mechanical resistance of fibers⁷.

There is a reduction in the number of fibroblasts in the periodontal ligament and also in its functional activity, which includes the mitotic and synthesis ability. There is also a reduction in the organic matrix production and in vascularization, and an increase in the number of elastic fibers^{6-7,9-10}. The thickness of the periodontal ligament varies and may reduce due to the reduction in the force applied by masticatory muscles along the time in subjects with complete dentition or having dental elements with no antagonist⁷⁻⁸. On the other hand, when several elements are missing, there might be an overload on the existing remaining teeth, with consequent periodontal ligament thickening⁸⁻⁹. Therefore, it can be said that any alteration in the periodontal ligament width reflects the functional condition of teeth⁷.

A continuous deposition of cementum was observed, which leads to an increase in thickness of this tissue with age, mainly in the teeth apical region to compensate for the physiological wear of teeth¹⁰.

Radiographic exams revealed that the mean alveolar bone height was reduced in older patients in a population ranging from 20 to > 80 years of age¹¹. However, data should be analyzed with caution once some alterations in the bone tissue in the oral cavity are similar to those in other parts of the body. This reduction in height may be due to systemic

factors instead of being due to age-related alterations⁷.

Alterations in disease progression

The induction of gingivitis in subjects of different age groups and with healthy periodontium showed a similar plaque accumulation in old and young adults. Nevertheless, old adults developed a more severe gingivitis and with a greater number of inflammatory cells¹², demonstrating an infiltrate with a greater proportion of B cells and lower density of polymorphonuclear cells¹³. This situation reveals possible effects of aging on the quality of the immune response.

Modifying factors of periodontal disease

Periodontal changes during increasing age are not sufficient to account for all damage experienced by elderly patients. The clinical appearance of periodontal tissues in this population reflects age-related changes and accumulation of disease and trauma over time¹⁴⁻¹⁵.

Association between periodontium and systemic diseases

The influence of oral condition on general health has been well documented in the last decades. Infectious diseases, such as periodontitis, cause inflammation and contribute to levels of overall infection and inflammation in the body and may trigger the beginning and/or the progression of other diseases such as diabetes and arteriosclerosis¹⁶. There are two mechanisms through which infection and inflammation apparently located in periodontal pockets may harm general health: the passage of periodontal pathogens and their products into circulation (bacteremia), and the passage of locally produced inflammatory mediators into circulation. Both mechanisms can contribute to inflammatory systemic diseases¹⁷.

Diabetes mellitus

It is suggested that the potential interactions between diabetes and periodontitis seem to enhance the morbidity of these two diseases¹⁸. The chronic hyperglycemic condition of diabetes is associated with damage, dysfunction, or failure of various organs and tissues, including the periodontium, due to the increased risk for infections in patients with diabetes, impairment of the synthesis of collagen and glycosaminoglycans by gingival fibroblasts, and increased crevicular fluid collagenolytic activity¹⁹.

It has been demonstrated by a meta-analysis study²⁰ that patients with types 1 and 2 diabetes had worse oral hygiene and higher severity of gingival and periodontal diseases, compared to nondiabetic subjects. On the other hand, periodontal therapy with or without adjunctive antibiotic therapy in patients (mean age: 53 years) may influence the systemic conditions of patients with type 2 diabetes, leading to improvements in glycemic control and in the reduction of inflammatory markers²¹.

There is still much to know about the relationship between periodontitis and diabetes mellitus, and its mechanisms. Clinically, the decrease of periodontal pathogens as well as the improvement of the diabetic

condition should be sought to slow down the progression of the disease or promote tissue repair.

Coronary heart disease (CHD)

Periodontal and cardiovascular diseases are common inflammatory conditions in the human population, atherosclerosis being the major component of the latter. In the atheroma formation, inflammation plays a continuous role from endothelial cell expression of adhesion molecules to the development of the fatty streak and established plaque, which is surrounded by a fibrous cap and narrows the lumen of the affected vessels, compromising blood flow. The rupture of the atherosclerotic plaque may lead to thrombus formation and to the major clinical sequelae of atherosclerosis: coronary thrombosis, acute myocardial infarction and stroke²².

A meta-analysis study indicated that individuals with periodontitis had 1.14 times higher risk of developing coronary heart disease²³. The more severe the periodontal disease the easier the periodontal pathogens could enter the circulation, reaching blood vessels and atherosclerotic lesions. The chronic and cyclic nature of periodontal diseases provides multiple opportunities for repeated bacteremia and affection of endothelial integrity²⁴⁻²⁵, perpetuating inflammatory events in atherosclerosis²².

Another linkage between periodontal disease and CHD is the level of C-reactive protein, which is an acute-phase reactant in response to infection or trauma and its high sustained level was associated with advanced periodontitis²⁶. Additionally, it is suggested that high levels of C-reactive protein are also related to CHD. Ridker *et al.*²⁷ demonstrated that C-reactive protein levels predict the risk of coronary events, although, there is still no consensus whether this protein contributes to atherogenesis or is a marker of atherosclerosis²⁶.

There are many traditional risk factors for cardiovascular disease, such as cigarette smoking, hypertension, high low-density lipoprotein cholesterol level, low high-density lipoprotein cholesterol level, diabetes mellitus, family history of premature CHD, age, obesity, physical inactivity and an atherogenic diet. However, Ridker *et al.*²⁸ reported that individuals with low low-density lipoprotein cholesterol levels, but high C-reactive protein levels were at greater risk for cardiovascular events than those with high low-density lipoprotein cholesterol levels but low C-reactive protein levels. This may highlight the attention for other risk factors, in addition to the traditional ones, as periodontal disease to the onset or progression of CHD.

Chronic renal disease

Chronic renal disease and renal replacement therapy can affect oral tissues and can greatly influence the dental management of the renal patient. Otherwise, chronic adult periodontitis is suggested to contribute to overall systemic inflammatory burden, with possible consequences in the management of the end stage renal disease patient on hemodialysis maintenance therapy²⁹. Additionally, some of the most common causes for end-stage renal disease are diabetes mellitus and chronic hypertension, which are also

associated with periodontal disease. Moderate to severe periodontitis appears to be highly prevalent in the renal hemodialysis population, and was associated to overt nephropathy and end-stage renal disease in subjects with type 2 diabetes³⁰ and to death of end-stage renal patients from cardiovascular causes³¹. Thus, it is suggested that periodontal therapy, which may reduce systemic inflammation, could be a treatment consideration for this population.

Other conditions

Depression – The association between periodontitis and depression may be related to psychoneuroimmunologic changes, damaging behavior, or a combination of both³². At-risk behavior includes a disinterest in performing appropriate oral hygiene techniques, a cariogenic diet, reduced salivary flow, rampant dental caries, advanced periodontal disease and oral dysesthesias. Additionally, several medications used for the treatment may intensify xerostomia and increase the incidence of dental disease³³. People with chronic diseases are at high risk of developing depression, once this psychological condition was present in 40% of the patients with CHD³³, and a positive relation between psychosocial factors and periodontal disease was found by 57.1% of the studies analyzed in a systematic review³⁴. Thus, it is suggested that depression therapy may be an important procedure for periodontal health maintenance³².

Immunosuppression – It is suggested that immunocompromising conditions do not predispose the subject to periodontal disease; however, it has been reported that the prevalence of periodontal disease is increased in HIV-positive when compared to HIV-negative subjects³⁵. Additionally, immunocompromised HIV-positive patients with preexisting periodontitis may have their oral condition exacerbated³⁶. Regarding the treatment improvement and the increase in life span for HIV patients, a higher prevalence of this condition may be found in the elderly. Basic periodontal therapy using mechanical technique improved gingival condition in 78.2% of HIV-positive and AIDS patients after 6 months of therapy, showing that even under immunosuppression, mechanical therapy is important for maintenance of periodontal health³⁷.

Neurodegenerative disease – Dementia, as well as reduction in cognitive ability, are common in the elderly and have been related to a higher index of periodontal disease in patients over 60 years of age³⁸. It has been suggested that inflammation within the brain may play a role in the etiology and pathogenesis of Alzheimer's disease. As peripheral infection/inflammation, such as periodontitis, may affect inflammatory systemic state, including the central nervous system, chronic periodontal disease has been also associated to this type of dementia³⁹.

Subjects with Parkinson's disease also present poorer oral health comparing to controls, including more missing teeth, caries, dental plaque, and poorer periodontal health, due to the lack of muscular control⁴⁰. It is of great importance that neurodegenerative patients and their caregivers must be oriented about the need for monitoring oral hygiene procedures in these individuals³⁸ and professional periodontal health maintenance.

Obesity - An association between obesity and periodontal disease has been presented, which cause could be related to biological or behavioral determinants in common⁴¹. Increased food intake and reduced physical activity may be accompanied by other changes in health related behaviors resulting in poorer periodontal health, as well as an elevated risk of cardiovascular disease and type 2 diabetes⁴². Association between the measures of body fat and periodontal disease was found among younger adults, but not middle or older adults⁴³. This result was not confirmed neither by Ylostalo *et al.*⁴¹, who found this association among non-diabetic, non-smoking subjects aged 30-49, nor by Linden *et al.*⁴², who found that obesity (BMI > 30) was associated with low-threshold periodontitis, once obese older adults from 60 to 70 years of age, presented a greater number of sites with periodontal pockets deeper than 5 mm⁴². Studies were adjusted for confounders as smoking, diabetes, education, oral hygiene and dental attendance^{41,42}. It has been suggested that focus on prevention in individuals at risk of developing obesity may benefit both general and dental health⁴².

Osteoporosis - A systematic review about oral implication of osteoporosis showed that individuals with reduced systemic bone density presented high periodontal bone loss, tooth loss and temporomandibular joint bone loss⁴⁴. In addition, older adults with osteoporosis had higher periodontal attachment loss⁴⁵, while subjects aged 65 years and older, who took calcium and vitamin D supplementation presented less tooth loss than subjects taking no supplementation over a 5-year follow-up⁴⁶. Despite these findings, the relationship between systemic and oral bone loss, and periodontal disease is not well established. However, it is suggested that findings in clinical and radiographic exams, may help dentists identifying patients with undetected low bone mineral density and refer them to medical professionals⁴⁴.

Drugs

Montenegro *et al.*⁴⁷ reported 46 oral side effects after evaluating the 8,635 commercial drugs most used by the elderly, and stated that oral side effects present great incidence and cause many difficulties to this population (Figure 1). Despite this, 21.6% of the drugs did not present any information concerning oral side effects. It is believed that these and some other important data that should be found in the prescribing information might have been neglected, rather than only the absence of side effects⁴⁷.

Among gingival and periodontal problems observed, gingival overgrowth with false periodontal pocket formation is included. This condition promotes bacterial plaque accumulation and makes oral hygiene procedures more difficult. Calcium channel-blocking and immunosuppressive drugs used in the treatment of angina, arterial hypertension and cardiac arrhythmias and also in the management of transplanted patients, respectively, show such characteristics³⁶.

Indirect damage to oral tissues may also be promoted by reduced salivary flow. It is well known that saliva is an important fluid for oral health and its reduction may cause gingivitis and a decrease in antimicrobial activity⁴⁸, among other disorders, which may affect health and quality of life. According to Nagle and Hershkovic⁴⁹, elderly people present

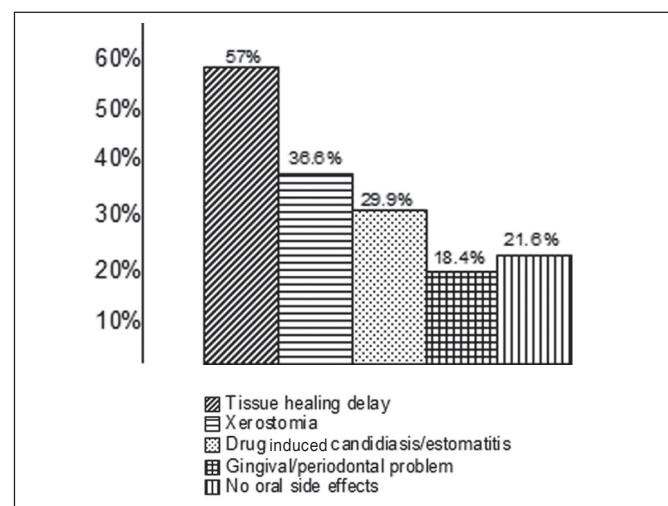


Fig. 1. Percentage of drugs presenting oral side effects reported in prescribing information, medicine guides and textbooks from a total of 8,635 drugs used by the Brazilian elderly population (Adapted from Montenegro *et al.*⁴⁷).

a reduction of most salivary components, as well as salivary flow decreased by 62% when compared with younger people, limiting its protective capacity, and turning saliva into a highly concentrated fluid, which compromises its lubrication and moistening abilities. There was no difference either in salivary flow or in saliva composition comparing older adults who used and did not use medications. However, although individuals who used drugs presented more extensive oral sensorial complaints, including xerostomia, it was suggested that salivary alterations were directly related to age rather than disease and/or drug use⁴⁹.

Systemic diseases as well as the use of medicines like antihypertensive and antiparkinsonian drugs, which are most used by the elderly, are pointed as the main causes of xerostomia. In a previous study, patients aged 67 to 96 years with poor health were examined. Almost 53% of them presented very low salivary flow, and this condition was strongly related to endocrine diseases, and the use of ophthalmologic and respiratory drugs, as well as potassium chloride. It was not possible to identify the effect of each drug. However, the number of drugs used daily, which ranged from 0 to 14, appear to be a key factor to the reduced salivary flow⁵⁰.

As many chronic diseases are found and many drugs are usually used by older adults even in healthy conditions, prescribing a drug is of major importance and responsibility, and involves an interdisciplinary focus, in order to reduce damage and improve patient's quality of life⁴⁷.

Behavioral and environmental modifiers

Tobacco smoking - Smokers are at a higher risk of developing periodontal disease, once tobacco may affect vascularization, the immunologic and inflammatory systems³⁶, attachment and function of fibroblasts, and increase the prevalence of periopathogens⁵¹. In a previous study, smokers over 50 years of age showed more sites with bacterial plaque, deeper probing depth and higher periodontal attachment loss when compared to former smokers or to non-smokers of the same age. Additionally, smokers had a

diminished response to periodontal therapy and present 4.8 times more risk of developing periodontitis than non-smokers⁵². The amount of cigarette consumption is also associated with higher risk for having moderate and severe periodontitis⁵². As quitting smoking reduced the risk of having periodontal disease⁵², dental professionals should be more active in smoking cessation counseling, in order to achieve positive effects in patient's health⁵¹.

Stress - Genco et al.⁵³ observed that emotional distress was a significant risk factor for individuals from 25 and 74 years of age having financial problems, once differences for stress were related to different levels of periodontitis. Stressed individuals showed higher pro-inflammatory cytokine level⁵⁴, this psychological condition being a possible positive influence on chronic periodontal disease³⁴. Additionally, stress may affect the host immune response, making the individual more susceptible to the development of unhealthy conditions³⁴, which are commonly found in elderly. Thus, stress might exacerbate periodontal disease, especially in older patients. In addition, stressed individuals may adopt harmful habits, such as, altering oral hygiene habits, intensification of smoking and changing eating habits, worsening the periodontal condition⁵³.

Discussion

Age-related periodontal alterations do not seem to be responsible for the high incidence of periodontal disease in the elderly population. The deterioration of periodontal tissues found in older adults may seem to be the result of the accumulation of diseases and traumas acquired throughout the lives of these individuals¹⁴⁻¹⁵.

Older patients are more susceptible to systemic diseases, their associations and, consequently, to the use of systemic medical therapies. Moreover, the elderly population is exposed to environmental and social factors for a longer time than younger people, increasing the susceptibility of the elderly population to possible changes in these factors.

According to Seymour et al.¹⁶, infectious diseases, such as gastrointestinal, respiratory and periodontal diseases, may contribute, alone or in combination, to the overall infection state of the individual. In the same way, infectious diseases and systemic conditions, such as obesity, emotional distress, autoimmune diseases, as well as social factors like smoking, are related to the increase in inflammatory markers. They may also contribute to the overall inflammation state of the body, worsening periodontal disease and other important diseases, such as arteriosclerosis and diabetes mellitus.

Type-2 diabetes is frequently observed as part of a multifactorial syndrome that includes obesity and arteriosclerotic cardiovascular disease⁵⁵. Periodontal disease has also been related to such conditions, which shows that it may be part of a systemic net, contributing to the general inflammatory state of the individual¹⁶. Despite these findings, more studies are needed to clarify the relationship between periodontal disease and diabetes mellitus, mainly on the treatment effects on this condition. Clinically speaking, the reduction in periodontal pathogens and the control of diabetes should be achieved in order to reduce the speed of disease progression and promote tissue repair.

As for cardiovascular diseases, there are several traditional risk factors, such as smoking, arterial hypertension, high levels of low-density cholesterol (LDL), low levels of high-density cholesterol (HDL), diabetes mellitus, family history among relatives of premature coronary disease, age, obesity, physical inactivity and an atherogenic diet²². Ridker et al.²⁸ suggested that the level of C-reactive protein is a stronger predictor of cardiovascular events than the LDL cholesterol, popularly known as a risk factor. This is an important finding, which suggests that the clinical interest must focus beyond traditional risk factors and must also consider other factors, such as the periodontal disease as a contributor to the coronary disease onset and progression.

Drugs commonly used by the elderly may cause oral side effects, such as gingival overgrowth and salivary flow reduction⁴⁷. Whenever possible, these drugs should be replaced in agreement with the patient's physician, but the dentist must be aware of the medical history and orient the patient about the importance of periodical visits for controlling bacterial plaque. Measures for the induction or replacement of salivary flow have to be considered, when necessary, in order to minimize the effects of hyposalivation and xerostomia.

When treating the elderly, the dentist has to take into account the physiological alterations in the oral cavity, as well as obtain accurate information on medical problems, drug regimen and possible limitations of patients of this age group, such as limited motor skills to keep good oral hygiene¹⁵. According to Duval and Leport⁵⁶, simple everyday habits like toothbrushing, flossing and chewing may cause bacteremia. Therefore, to avoid the contribution of the cumulative and spontaneous effect of microorganisms entering the bloodstream to overall generalized infection and inflammation, it is necessary to adopt a preventive strategy to reduce the source of oral bacteria by means of adequate oral hygiene and regular professional care. Once periodontal disease is a consequence of lifetime damages, the best conduct for patients is to seek professional advice in order to prevent the disease since an early age. It is possible then, to reduce the risk of developing, worsening or perpetrating some systemic conditions at old age.

In conclusion, only age-related periodontal alterations may not seem to have clinical significance. Associations among such alterations and systemic diseases, medicines and behavioral and environmental factors may significantly compromise the well-being of the elderly. The relation between periodontal disease and some systemic diseases seems to have a double meaning effect, that is, it seems to increase morbidity in both conditions.

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