Aging and Periodontal Disease

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Abstract: *Aging is an inevitable consequence. Maintaining successful aging is essential for the older population. Understanding how aging affects the periodontium enables us to promote healthy aging in the elderly population. Periodontitis is one of the most common diseases among geriatric people. Gingival recession is the most common feature of the senescent periodontium. In the older population, periodontal disease is caused due to the cumulative effect of aging on the periodontium and immunosenescence. The older population is particularly vulnerable to frailty brought about by aging, which makes it harder for them to practice oral hygiene. Systemic diseases like atherosclerosis, hypertension, pneumonia, COPD, diabetes mellitus, Alzheimer's disease, and osteoporosis have a bidirectional link with periodontitis which also increase the systemic inflammatory condition. The main goal of treating the geriatric population is to make a self-cleansing, plaque-free oral environment. With increased health awareness and better dental care, older people can achieve intact dentition with limited periodontal attachment loss. This paper highlights the various aspects of aging periodontium with special emphasis on the different treatment modalities practiced in geriatric patients.*

Keywords: Aging, Periodontal disease, Periodontitis, successful aging

Introduction

Geriatrics is a Greek-derived word in which 'Geron' means Oldman, and 'iatria' means treatment of disease. According to the United Nations, the geriatric population are the people aged above 65 years and presently hold for 11% of the world's population and is expected to grow up to 22% by 2050 [1]. The older population is classified into,

Table 1. Classification of Geriatric Population [2]

New/ young elderly	65 -74 years	Relatively healthy & active
Old/ mid old	75 - 84 years	Vary from healthy & active to those managing an array of chronic diseases
Oldest/ old	≥85 years	Physically frailer; the fastest growing section of the older adults

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A geriatric patient is an older individual with impaired overall functions, chronic illness, physical impairment, and/ or cognitive impairment; Geriatric people are more prone to developing diseases and mostly chronic. WHO has recognized and prioritized the older population's quality of life as a primary concern. Many factors influence whether a person develops a chronic disease or not. While exposure to bacteria and viruses is the primary cause of the majority of illnesses, inflammation is a major factor in many age-related illnesses and can affect many organs. Periodontitis is a chronic, multifactorial inflammatory disease that affects both the soft and hard tissues surrounding the tooth, which can result in tooth loss and lower quality of life in terms of oral health.

The multifactorial nature of the periodontal disease means that the inflammatory response of the periodontium is influenced by the genetic makeup of a person also environmental stresses and/or systemic disease play a vital role in the pathogenesis of the disease. The question of whether periodontitis is a sign of physiological aging or merely a result has been disputed for a very long time. This review will cover the biology of aging, what constitutes successful aging, the characteristics of the senescent periodontium, how aging affects the pathogenesis of periodontitis, the prevalence of periodontal disease in older populations, risk factors of periodontal disease in older populations, how systemic diseases influence the progression of periodontal disease in the older population, how to prevent periodontal disease and methods to treat it in older people.

Biology of aging & successful aging

Every tissue in the body is affected by aging. In biological terms, aging is referred to as "a time-dependent functional deterioration that affects all living creatures" [3]. The loss of physiological integrity caused by this functional deterioration leads to diseases such as cardiovascular disease, cancer, diabetes, and neurological problems.

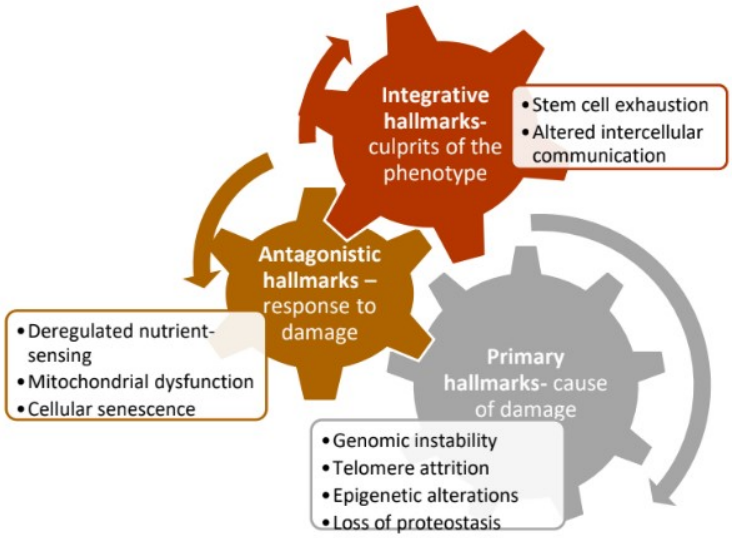

Figure 1. Hallmarks of Aging [3]

Maintaining successful & healthy aging in the elderly population is crucial. According to **Rowe & Kahn** [4], successful aging has three components (Figure 2).

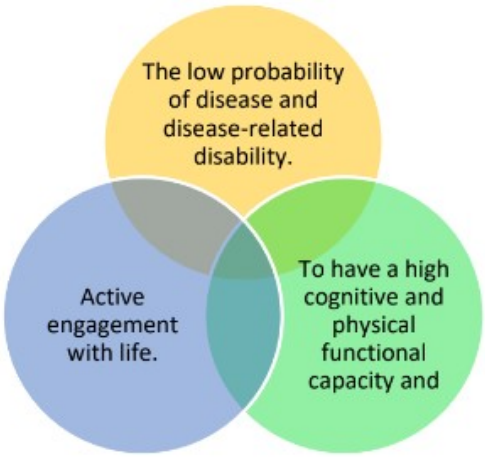

Figure 2. Components of Successful Aging

In terms of oral ageing, the WHO proposed that successful aging is defined as having more than 20 teeth when one is 80 years old. Extensive tooth loss reduces chewing efficiency [5]. Chewing with removable dentures is 30% to 40% less efficient than chewing with natural teeth [6]. Thereby affecting overall health. When this idea is applied to periodontal tissues, successful periodontal tissue ageing is defined as having an intact dentition with limited periodontal attachment loss and, and minimal limitation in function.

Rationale

Understanding the impact of aging on periodontium is critical because,

- It improves preventative dentistry and increased health awareness thereby resulting in lower tooth loss in all age groups.
- When people live longer, their demands for periodontal treatment shift, thereafter supportive periodontal therapy should be increased.

Senescent periodontium

The periodontium, defined as the tissues that surround and support the teeth, includes the gingiva, bone, cementum, and periodontal ligament. One of the consequences of aging is the loss of physiological integrity and functio laesa. In terms of periodontal tissue aging alterations in connective tissue were seen. The senescent periodontium in the older population most commonly experiences gingival recession which is characterized by connective tissue attachment loss and alveolar bone loss.

Histological connective tissue alterations are-

- Elastic fiber numbers were reduced
- Disorganized collagen bundles
- Diminished cellular content
- Changes in the functional & structural changes of gingival fibroblast
- Decrease in collagen production by gingival fibroblasts
- Reduction in the keratinized gingiva

As a result, the structure & function of the periodontal ligament also deviates irregularly. Periodontal tissues are reduced yet functional

- Mobility of the tooth increased which is physiological
- Probing pocket depth is ≤ 4mm
- Clinically tooth height is increased due to an increase in crown root ratio

- Gingival inflammation is seen in many areas

Deviations from these are considered pathologic.

Periodontitis

Periodontitis is characterized by microbially-associated, host-mediated inflammation that results in loss of periodontal attachment. This is detected as clinical attachment loss (CAL) by circumferential assessment of the erupted dentition with a standardized periodontal probe with reference to the cemento-enamel junction (CEJ).

Periodontitis begins with bleeding gums and progresses to tooth mobility, eventually leading to tooth loss. Asymptomatic in most cases. According to the 2017 classification, a periodontitis patient is one with interdental clinical attachment loss in ≤ 2 non-adjacent teeth / probing pocket depth of >3mm at ≥ 2 teeth.

Periodontal disease in the aging population

Periodontitis is the sixth most common disease and the second most dental disease affecting the population of the world. About 11% of people are affected by severe types of periodontitis worldwide [7]. In a systematic review done on the global burden of disease in 2012, periodontal disease places 31st position for the reason people living with disability worldwide.

Papapanou et al (1992) [8], in a cross-sectional study, found that people aged <45yrs had increased alveolar bone loss however people aged >50 years had no alveolar bone loss in later life. Whereas, Persson et al (1998) [9], found that people aged >50 years also had progressive periodontitis and stated that periodontitis is not an age-related problem. **Albander et al** (1999) [10] found that periodontal disease was less common in people aged above 80 years, possibly due to the loss of teeth with the highest susceptibility to periodontitis. It was challenging to determine if periodontal disease is an unavoidable result of ageing or that ageing will influence the evolution of periodontal disease because of the contradicting findings in the earlier studies. Because the index teeth used in the studies have varied and there are no precise diagnostic criteria to classify periodontal disease.

Eke et al (2015) [11], used National Health and Nutrition Examination Survey (NHANES) data, and grouped periodontal disease according to their severity for the United States population. He stated that chronic periodontitis affects more than two-thirds of people over the age of 65. Therefore, it is crucial to be aware that the elderly population is more likely to acquire periodontal disease and is more susceptible to its progression.

Pathogenesis of periodontal disease in older people

Multiple hypotheses have been stated for the pathogenesis of periodontal disease in the older population. Among them, the two important hypotheses discussing the cumulative nature and age-altered susceptibility of older individuals [12].

1. Cumulative hypothesis

This hypothesis discusses how timespan plays an important role in pathogenesis of periodontal disease. Prolonged exposure to the periodontal pathogens and their accumulated tissue damage leads to periodontal tissue breakdown.

2. Age-altered susceptibility

Aging is associated with altered immune status by decreased function making the older population susceptible to periodontal disease which is called "immuno-senescence".

Immuno-senescence is the decline in the function of the immune system brought on by natural age advancement. It may also contribute to the increased susceptibility of older individuals to microbial infections. Older people display a decline in the number of native T-cells in peripheral blood and lymphoid tissues, whereas the proportions of highly effector and memory T-cells increases [13].

This concept is supported by the experimental gingivitis conducted by **Holm-Pederson et al** [14], that older people developed gingivitis which is rapid and severe compared to younger individuals. Other findings of this study include, Increased biofilm accumulation, GCF volume and GCF levels of α- macroglobulin & Ig-G3. Gingival biopsies showed, increased inflammatory cell infiltration with a higher proportion of B-cells and decreased density of neutrophils.

In addition to the previously described hypotheses, microbial dysbiosis has also been put forth as a potential cause of the prevalence of periodontal disease in older people. However, a recent study by **Feres et al.** (2016) [15] has disproved this notion. He examined changes in the periodontal microflora as a possible underlying cause for the increased prevalence of periodontitis associated with aging but found no significant alterations in the subgingival microflora that could be attributed to aging.

Risk factors for periodontal disease in older people

The factors which increase the likelihood of developing a disease are called risk factors. The risk factors for periodontitis are the same in older persons as they are in younger people. Age, gender, race/ethnicity, income, education, and dental appointments are among them. However, the more apparent risk factor in older people is frailty.

Frailty is an age-related syndrome of increased vulnerability and decreased physical status and activity. A person is considered frail if three out of five phenotypes are present:

1. Unintentional weight loss,
2. Reduced grip strength,
3. Reduced walking speed,
4. Low endurance/ energy,
5. Limited physical activity.

Being frail makes the older people difficult to maintain proper oral hygiene, which contributes to the development of periodontal disease. Poor oral hygiene and tooth loss, on the other hand, impair masticatory efficacy and make a person frail. Geriatric people often present with chronic diseases like diabetes mellitus, increased use of medication, and multimorbidity which predisposes them to periodontal destruction.

Systemic diseases & periodontal disease in the older population

There exists a potential link between systemic health and periodontal disease. In periodontal disease, the bacteria & bacterial toxins enter the bloodstream through the pocket epithelium and get disseminated throughout the body increasing the systemic inflammatory state. This might exacerbate other chronic inflammatory diseases. This increased chronic inflammatory condition is termed as 'inflammaging' which is frequently associated with human aging [16].

Periodontitis in older patients is associated with elevated systemic inflammatory markers like IL-6, TNF & C-reactive protein which is a contributing factor to inflammaging [17]. However, it is unclear whether inflammaging leads to the development of inflammatory or degenerative chronic diseases. Systemic complications

common in the older population that have been associated with periodontitis include cardiovascular disease, respiratory diseases, diabetes mellitus, Alzheimer's disease and osteoporosis,

Cardiovascular disease

In atherosclerosis, the arterial plaques build up along the walls making them hard and narrow. This will either block the blood flow or burst to form a clot. Evidence of periodontitis patients exhibiting increased arterial stiffness has been noted. Periodontal pathogens - *Tannerella forsythia, Prevotella intermedia*, and *Porphyromonas gingivalis* have been discovered in atherosclerotic plaques [18]. A meta-analysis report by **Bahekar et al (2007)** [19], states that periodontal disease patients are at 1.14 times increased risk of developing coronary heart disease. Hypertension is another common highly prevalent disease seen in older people. There exists a statistically significant association between hypertension & periodontal disease [20]. But the underlying mechanism linking their association is inconclusive.

Respiratory disease

Chronic Obstructive Pulmonary Disease (COPD) & Pneumonia are the most common respiratory diseases in older people.

COPD is a chronic, hyperactive inflammatory response causing irreversible lung damage resulting in difficulty in breathing. NHANES study stated that patients with COPD exhibited greater clinical attachment loss indicating periodontitis as well as the presence of periodontitis was associated with an increased risk of COPD & decreased lung function]21]. One proposed pathophysiological mechanism is the aspiration of pathogenic periodontal pathogens which might not get cleared well in COPD patients. Similarly, the oral cavity act as a repository for these respiratory pathogens [22]. The second one is that both COPD & periodontitis are chronic inflammatory conditions. The disseminated periodontal pathogens in the bloodstream upregulate the adhesion receptors in the respiratory mucosa thereby increasing the colonization of bacteria. Expectorated bronchial secretions containing bacteria and by-products of inflammation in the oral cavity contribute to an increase in periodontal inflammation. Even though both periodontitis & COPD share pathophysiological mechanisms, they also share smoking as the primary risk factor. Much research is needed to differentiate pathological correlation from confounding factors.

Pneumonia- older patients admitted to the Intensive Care Unit are more prone to develop Hospital-acquired (nosocomial) pneumonia which is a severe form. The pulmonary pathogens colonizing the dental plaque get aspirated causing pneumonia. Systematic review by ***Scannapieco et al (2003)*** [23] states that professional dental cleaning & topical antimicrobial usage have reduced the incidence of nosocomial pneumonia.

Diabetes mellitus (DM)

Diabetes severely affects older people's quality of life. Both type- I & type- II DM are major risk factors for periodontitis along with a bidirectional relationship between DM & periodontitis [24]. DM increases the local levels of RANKL, OPG, TNF-α, IL-1β, and IL-6 thereby increases the susceptibility to infection & upregulates the local inflammation [25]. Interaction between Advanced Glycated Endproducts (AGEs) also plays an important role in severe tissue destruction & impaired repair in diabetes patients with periodontitis while periodontitis impairs glycemic control & treatment response in diabetic patients by increasing the systemic inflammation. The progression of

periodontitis is more rapid in DM patients. Scaling & root planing improves glycemic control in type-II diabetes patients.

Alzheimer's disease (AD)

Alzheimer's disease is a neurodegenerative disorder characterized by progressive synaptic loss and the formation of neurofibrillary tangles and amyloid-ß (Aß) plaques in the frontal neocortex and limbic systems of the brain. Alzheimer's disease, patient's poor oral hygiene is seen due to reduced manual dexterity/ inability to receive professional dental care. Age-related cognitive impairment has been linked to tooth loss, and the presence of serum antibodies to periodontal disease indicators has also been reported in older people [26,27]. Evidence supports that peripheral inflammation has an aggravating effect on the brain's innate inflammatory response [28].

Periodontitis-induced systemic inflammation is considered a plausible mechanism for the onset & progression of Alzheimer's disease. Firstly, periodontal bacteria elicit increased levels of pro-inflammatory cytokines in the systemic stream which passes through the BBB (Blood-brain barrier). Another mechanism is the colonization of the brain by periodontal bacteria through the bloodstream or nerve-associated channels. It is supported by the fact that *P. gingivalis, T. denticola,* and *T. forsythia*, have been found in the brain tissue of Alzheimer's disease patients [29,30].

Osteoporosis

Osteoporosis is a condition with systemic loss of bone density, including the alveolar bone which in turn accelerates periodontal disease progression. Osteoporosis affects both older men & women, yet older postmenopausal women are predominantly affected. Several studies illustrate a relationship between periodontal disease & osteoporosis. Periodontal attachment loss associated with decreased bone mineral density has been observed in postmenopausal women [31]. According to **Choi et al (2017)** [32], women aged ≥ 50 years with periodontitis have been found to experience a higher incidence of osteoporosis than their counterparts without periodontitis. Inflammation plays a major role in the mechanism underlying the apparent relationship between periodontitis and osteoporosis.

Prevention of periodontal disease in geriatric patients

The major risk to periodontal health in older people results from poor oral hygiene. According to **Renvert et al (2011)** [33], older people under regular dental visits have retained more teeth than those who are not. Although it doesn't appear that the frequency of dental visits has an impact on the levels of alveolar bone, gingival inflammation, or plaque accumulation. Reasons for older people ignoring oral hygiene include frequent medical problems and psychological alterations during aging. These reasons demotivate them from practicing regular oral hygiene measures. To overcome this both medical & dental professionals need to work together. Medical professionals should emphasize the importance of oral hygiene in general health, and dental professionals should motivate older people in oral hygiene measures and customize it according to their needs.

Some of the oral hygiene measures which can help patients with chronic, disabling medical conditions (e.g., arthritis, neurologic impairment) are, using toothbrushes with wide-handle grips, floss-holding devices, and electronic brushes. Older people consuming multiple medications for their systemic ailment would make them prone to develop xerostomia. Due to their decreased salivary flow, they are more prone to developing dental caries and periodontal disease. Hence, they are advised to use chlorhexidine rinses, fluorides, and over-the-counter salivary substitutes.

Periodontal treatment aspects in geriatric patients

Treating geriatric patients with periodontal problems should be viewed from a broad perspective. These involve modifying general health risk factors by, improving the metabolic control of diabetes mellitus, and cessation of smoking if present. Oral health risk factors by, toothbrush handle modification that helps older people with arthritic changes in hands, frequent oral prophylaxis.

Non-surgical & surgical therapy

Non-surgical therapy mainly aims at removing biofilm and the ultimate goal of surgical therapy is to create an environment that helps in plaque control not purely on the reduction of probing depth. However, delayed wound healing is seen in the older population due to decreased collagen formation and increased matrix metalloproteinase production by the gingival fibroblasts.

Dental implants therapy

Although dental implants are not a contraindication for older people, the increased inflammatory responses observed in older patients might impede the osseointegration process of dental implants. To sustain dental implant health in the older population, it will be crucial for both the elderly and those who care for them to receive oral hygiene education.

Conclusion

Research shows that healthy supporting periodontal tissues can be retained in older patients, suggesting that aging does not always cause clinical attachment and as well as alveolar bone loss, since inflammation is a common factor related to aging and periodontal disease, their symptoms begin to overlap, which has syndemic repercussions. Thanks to increased health awareness and better dental care nowadays people retain natural teeth for a longer period than before. Successful aging, aesthetically pleasing, and remaining functional teeth are more common among older people. Hence, dental care providers must be aware of and be prepared for the challenges in treating the future older population.

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