Periodontal disease and osteoporosis association and mechanisms: 
A review of the literature

Abstract

Periodontitis and osteoporosis, diseases that affect millions of people in world, present bone loss as common hallmark. Prevalence of both osteoporosis and tooth loss increase with advancing age in both women and men. Systemic bone loss has been proposed as a risk factor for periodontal disease with increasing evidences that osteoporosis, and the underlying loss of bone mass characteristic of this disease, is associated with periodontal disease and tooth loss. Periodontitis has long been defined as an infection-mediated destruction of the alveolar bone and soft tissue attachment to the tooth, responsible for most tooth loss in adult populations. Current evidences including several prospective studies support an association of osteoporosis with the onset and progression of periodontal disease in humans. Systemic loss of bone density in osteoporosis, including that of the jaw, may provide a host system that is increasingly susceptible to infectious destruction of periodontal tissue. Studies have provided evidence that hormones, heredity, and other host factors influence periodontal disease’s incidence and severity. This paper reviews the role of estrogen deficiency and osteoporosis in oral bone healthy and the current evidences on the association between periodontal disease and osteoporosis.

Key Words:
Age , bone loss, periodontitis, osteoporosis

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Introduction
Periodontal disease is initiated by microbial pathogens that elicit a host immune response with subsequent tissue destruction of the periodontal structures, including breakdown of alveolar bone. Although bacteria are a necessary factor in the equation, the reaction of the host’s immuno-inflammatory system is responsible for most of the destruction found in periodontal disease. Thus, it makes sense that a number of environmental and acquired factors may modify a patient’s risk of developing periodontal disease. Recently, it has been suggested that estrogen can influence tooth retention by preventing the resorption of alveolar bone. Estrogen deficiency, which affects systemically the sequence of bone resorption and formation, has received increasing attention in relation to the stability of alveolar bone structure in postmenopausal women. This paper reviews the scientific evidence for some of the periodontitis risk factors including age and osteoporosis.

OSTEOPOROSIS - BIOLOGICAL ASPECTS

1.1 Bone Remodeling
A balance process of bone resorption continuously remodels normal bone, including alveolar bone, by osteoclasts, followed by bone deposition by osteoblasts. Osteoblasts secrete bone matrix proteins, including type-I collagen, proteoglycans, osteocalcin, osteopontin and the growth factors and, later stimulate the bone mineralization. Osteoclastogenesis is also under the control of osteoblasts, since osteoblasts are affected by factors capable of promoting bone resorption, such as parathyroid hormone (PTH), 1,25 dihydroxyvitamin D3, calcitonin, and prostaglandin E2 (PGE2). Unlike osteoclasts, osteoblasts do not have a hematopoietic lineage, but are derived from mesenchymal precursors. Precursor cells are attracted chemotactically, then bone cell mitogens, including transforming growth factor beta (TGFβ), platelet-derived growth factor (PDGF), bone morphogenetic protein, fibroblast growth factor and insulin-like growth factors-I and –II, induce their proliferation and differentiation to osteoblasts. Many of these growth factors are released as bone cell mitogens, including type-I collagen, proteoglycans, osteocalcin, osteopontin and the growth factors and, later stimulate the bone mineralization.

1.2 Osteopenia/Osteoporosis
Osteopenia is defined as a reduction in bone mass due to bone resorption. The reduction in bone mass and deterioration in bone architecture, that may occur after age 40, is characteristic of osteoporosis resulting in increased fragility of the bone and its susceptibility to fractures. In 50-years-old Caucasian American women, the lifetime risk for total osteoporotic fractures and hip fractures is 45% and 17.5% respectively. About 25 to 30% of all hip fractures occur in men, and male osteoporosis is increasing as men live longer, probably due to a decrease in sex steroids and age-related bone loss.

Osteoporosis can be further characterized as either primary or secondary. Primary osteoporosis can occur in both sexes at all ages, but often follows menopause in women and occurs later in life in men. In contrast, secondary osteoporosis is a result of medications (e.g. glucocorticoids) or other conditions (e.g. hypogonadism). Currently there is no accurate method to measure the overall bone strength. Bone mineral density (BMD) is frequently used as a proxy measure and accounts for approximately 70% of bone strength. The World Health Organization (WHO) operationally defines osteoporosis as bone density 2.5 SDs below the mean for young white adult women. It is not clear how to apply this diagnostic criterion to men and children, or across ethnic groups. Because of the difficulty of accurate measurement and standardization between instruments and sites, controversy exists among experts regarding the continued use of this diagnostic criterion.

Risk factors for osteoporosis
The prevalence of osteoporosis and the incidence of fracture vary by sex and race/ethnicity. Both men and women experience an age-related decline in BMD starting in midlife. Women experience more rapid bone loss in the early years following menopause, which places them at earlier risk for fractures. Risks associated with low BMD are supported by evidence that includes large prospective studies. Predictors of low bone mass include female sex, increased age, white race, low weight and body mass index (BMI), family history of osteoporosis, smoking, and history of prior fracture. Use of alcohol and caffeine-containing beverages is inconsistently associated with decreased bone mass.

The most common cause of osteoporosis in women is the decrease in estrogen that accompanies menopause. Estrogen loss is associated with elevated bone resorption caused by an rise crease in the cytokines that regulate osteoclast generation, as follows: RANK–ligand; TNF-a (tumor necrosis factor-a); interleukin-1 (IL-1), IL-2, IL-6; M-CSF (macrophage-colony stimulating factor), and prostaglandin E1. Production of all of these cytokines is either directly or indirectly suppressed or regulated by estrogen.

Glucocorticoid use causes the most common form of drug-related osteoporosis, and the long-term administration of glucocorticoids for disorders such as rheumatoid arthritis and chronic obstructive pulmonary disease is associated with a high rate of bone fracture. People who have undergone organ transplantation are at high risk for osteoporosis due to a variety of factors. Hyperthyroidism is also a well-described risk factor for osteoporosis.
Osteoporosis x Periodontal Disease

A number of studies have investigated a possible relationship between periodontitis and osteoporosis, and although the literature supports such relationship, its extent remains unclear, due to small sample sizes, noncomparable study populations and different study methods used to assess periodontitis and osteoporosis. In spite of these limitations, recent investigations have been designed to provide more specific information.

Periodontal disease is a chronic inflammatory disease that leads eventually to loss of the supporting structures of the teeth, including resorption of alveolar bone of the jaw. Periodontitis are the most prevalent of the diseases of the bone in humans, being severe enough to lead to tooth loss in 10 to 15% of adults and can be exacerbated by certain systemic factors, such as estrogen-deficiency.

Estrogen-deficiency enhances the rate of breakdown of connective tissue components of the gingiva by stimulating synthesis of matrix metalloproteinases (MMP-8, and MMP-13), nitric oxide and several cytokines implicated in bone resorption. Estrogen deficiency increases IL-6 concentrations in bone marrow, serum, and gingiva, cooperatively stimulating osteoclast bone resorption. A cross-sectional study of pre and postmenopausal women report significant correlation between alveolar and metacarpal BMD and elevated salivary IL-6 concentrations in postmenopausal women.

Preliminary data from the oral ancillary study of the Women’s Health Initiative, which was designed to determine a preliminary data from the oral ancillary study of the Women’s Health Initiative, which was designed to determine a possible association between systemic osteoporosis and oral bone loss, suggested a significant correlation between the mandibular basal bone mineral density and hip bone mineral density. Krall et al 2001 have correlated calcium and vitamin D supplements with a lower risk of tooth loss in elderly men and women.

Others have reported diminished tooth loss in estrogen users, gingival plaque and body mass index, the authors demonstrated that loss of skeletal bone mineral density was related substantially to alveolar bone loss. To a lesser extent, skeletal bone mass was also related to CAL (clinical attachment loss). These data implicate postmenopausal osteoporosis as risk indicator for periodontal disease in postmenopausal white women.

The relationship between skeletal loss of mineral density and increased periodontal bone loss may be due to several factors. It may be that more periodontal bone loss occurs simply because the bone surrounding the teeth is less dense and therefore less resistant to resorption. Genetic predisposition to systemic and periodontal bone loss also may be factor, as well as environmental or lifestyle factors that predispose some people to both diseases. Many possible factors contribute to the development of osteoporosis and periodontal diseases being difficult to establish the direct correlation between tooth loss, bone loss, and loss of attachment resulting from periodontitis and decreased BMD associated with osteoporosis, but studies are ongoing. Understanding the association between these common diseases and the mechanisms underlying those associations will aid health professionals to provide improved means to prevent, diagnose, and treat these very common diseases.

References