OSTEOPOROSIS AND PERIODONTAL DISEASE – A REVIEW
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ABSTRACT
Osteoporosis and periodontal diseases are bone resorptive diseases. Osteoporosis and osteopenia are characterized by reductions in bone mass and may lead to skeletal fragility and fracture. In most women, bone mass reaches its peak in the third decade of life (age 20 to 30) and declines thereafter. This decline in bone mass is accelerated with the onset of menopause, and oral symptoms are also found in addition to the systemic manifestations of menopause. This review deals with the assessment, mechanism and treatment of osteoporosis.

KEY WORDS:
Osteoporosis, Bone mineral density, Dual Energy X-Ray absorptiometry, Hormone replacement therapy

INTRODUCTION
Osteoporosis and periodontal diseases have been considered as the bone resorptive diseases. Both Osteoporosis and osteopenia are characterized by reductions in bone mass and may lead to skeletal fragility and fracture. In postmenopausal women, bone mass reaches its peak in the third decade of life (age 20 to 30) and declines thereafter. This decline in bone mass is accelerated with the onset of menopause, and oral symptoms are also found in addition to the systemic manifestations of menopause. An increased incidence is observed of oral discomfort, including pain, a burning sensation, dryness, and altered taste perception, as well as a debated rise in the prevalence of periodontal disease.

Periodontitis, an inflammatory disease characterized by resorption of the alveolar bone as well as loss of the soft tissue attachment to the tooth, is a major cause of tooth loss in adults. Since loss of alveolar bone is a prominent feature of periodontal disease, severe osteoporosis could be suspected of being an aggravating factor in the case of periodontal destruction. In
recent years, there has been increasing interest in the interrelationship between systemic osteoporosis, oral bone loss, tooth loss, and periodontal disease.\(^1\)

**DEFINITION**

Osteoporosis is defined as a skeletal disorder characterized by compromised bone strength predisposing an individual to an increased risk of fractures.\(^2\) Bone strength primarily reflects the integration of bone density and bone quality. Bone density is expressed as grams of mineral per unit area or volume, and in any given individual, is determined by peak bone mass and amount of bone loss. Bone quality refers to architecture, turnover, damage accumulations (e.g. Microfractures) and mineralization. The standard deviation is determined by certain established criteria namely: T-score which is defined as the number of standard deviations above or below the average Bone mineral density (BMD) value for young healthy white women and Z-score which is defined as the number of standard deviations above or below the average BMD for age and sex matched controls.

**CLASSIFICATION**

Following classification is based on standard deviation: The various methods for assessing bone are as follows\(^3,4\):

A) Systemic bone:

a) Absorptiometry
   - Single photon absorptiometry
   - Dual photon absorptiometry
b) Dual Energy X-Ray Absorptiometry (DEXA)
c) Quantitative Computed Tomography (QCT)
d) Measurement from radiographs
   - Measurement of cortical thickness and other indices
   - Fractal dimension
e) Ultrasound

B) Intra-oral Sites (Research tools):

a) Adaptation of absorptiometry or DEXA
b) Measurement from panoramic films
c) Cortical thickness and other indices
d) Measurement from intra-oral films
e) Measurement of bone or ridge height
f) Apparent bone density expressed as arbitrary units based on the reference wedge
g) Digital subtraction radiography (changes in bone height (mm) or density (mg/mm\(^2\))
h) Fractal dimension
i) Microdensitometry
j) Pixel intensity analysis

**ASSESSMENT OF OSTEOPOROSIS**

Osteoporosis is usually be assessed by a measurement of bone mineral density (BMD). BMD is expressed in terms of the number of standard deviations (SD) from the mean of healthy individuals, matched to age and sex (the Z-score), and the number of SD from the mean of healthy young sex-matched individuals (the T-score).\(^5\) According to the World Health Organization, Osteoporosis is considered to be present when BMD is 2.5 SD below the BMD of the young normal individual.
Osteopenia is defined as bone density levels between 1 SD and 2.5 SD below normal BMD. Fracture risk is approximately doubled for every 1 SD below the young adult mean BMD. There are several tools available to measure BMD. The most widely used tool for assessing Osteoporosis is dual-energy x-ray absorptiometry (DXA). Non-invasive DXA is reliably used around the world to identify patients with low BMD because of its high precision and resolution, high accuracy, low radiation dose, and low cost.

DXA remains the gold-standard assessment of osteoporosis. Dual-photon absorptiometry (DPA) is similar in concept to DXA, however, it is not as advantageous because it has a longer scan time and shorter source life. Prior to the development of Computerized Densitometry, Digital x-ray radiogrammetry (DXR) was used. This less precise technique estimates BMD by evaluating a standard radiograph of the hand.

A less common assessment test used by 2 studies in this review is the Quantitative Ultrasound (QUS) of the calcaneal and phalanges. It provides a measure of skeletal status by determining a Stiffness Index (SI), a measure of bone strength, which is sensitive to bone structure.

Another type of osteoporosis assessment method measures the thickness of the mandibular inferior cortex (MIC) below the mental foramen on a dental panoramic radiograph (DPR). The cortical bone was chosen over the trabecular bone due to its greater consistency among readings, which may be due to trabecular bone being more easily influenced by dental infections.

The porosity of the MIC is classified using the Klemetti Index. This classification system is an excellent means to determine undiagnosed osteoporosis. Based on MIC findings of erosion or thin cortical width on DPR, younger postmenopausal women could be identified as osteoporotic. A decrease in MIC thickness by 1 mm was shown to increase the likelihood of osteoporosis by 47%. Mild to moderate MIC erosion on the DPR correctly reflected the presence of osteoporosis 83% of the time, and a normal MIC reading predicted a normal BMD 60% of the time. This means that normal spine BMD would correlate with normal MIC evaluations on DPR greater than half the time. This method has great potential because DPRs are taken as part of routine dental examinations.

ASSESSMENT OF PERIODONTAL DISEASE

Many dental conditions affect the postmenopausal age group, including tooth loss and periodontal disease and prevalence increases with age. In the reviewed studies, periodontal disease was assessed with a diversity of outcome measures. In general, studies lacked concise and widely accepted assessment criteria for diagnosing periodontal disease, making comparisons among studies and conclusions challenging. Gomes-Filho proposed a gold standard of the combination of periodontal bone resorption (>3 mm) with 3 other clinical parameters for the disease: Pocket depth (PD) (>4 mm), clinical attachment level (CAL) (>3 mm) and Bleeding upon probing (BOP). These 3 clinical parameters had the greatest frequency among the
reviewed studies, with probing depth used 17% of the time, CAL 13% and BOP 15%, confirming that Gomes-Filho made a logical choice.

**RELATIONSHIP BETWEEN OSTEO-POROSIS AND PERIODONTAL DISEASES**

There is interrelationship between systemic osteoporosis, oral bone loss, tooth loss, and periodontal disease. It has been hypothesized that the breakdown of periodontal tissue may, in part, be related to systemic conditions that also predispose the patient to osteoporosis/osteopenia. Kribbs showed no significant differences in periodontal measurements (mean probing depth and attachment loss) between osteoporotic and normal groups. Another cross-sectional study demonstrated that periodontal attachment loss was correlated with tooth loss, but not with vertebral or proximal femur bone density. Elders and coworkers examined periodontal condition and measured lumbar bone mineral density (lumbar BMD) in 286 female volunteers between 46 and 55 years of age. No significant correlation was observed between the clinical parameters of periodontitis (mean probing depth, occurrence of bleeding after probing and number of missing teeth) and the lumbar BMD, nor was a significant relation observed between the bone mass measurements and alveolar bone height. Thus, they concluded that systemic bone mass was not an important factor in the pathogenesis of periodontitis. No statistically significant differences were found in gingival bleeding, probing pocket depth, gingival recession and marginal bone level between 15 women with osteoporosis and healthy subjects. No statistically significant association between the parameters of periodontal disease and measures of systemic BMD were found even after controlling some potential confounding factors of age, smoking and number of remaining natural teeth, (Weyant et al). Other authors have found a significant relation between systemic osteoporosis and loss of periodontal tissue. A case-control study comparing 12 osteoporotic fracture women and 14 normal women found that there was significantly greater loss of periodontal attachment in the osteoporotic women than in the normal women. Similar findings were shown in a cross-sectional investigation of the association between systemic BMD and periodontal status. In that study, thirty post-menopausal, Asian-American women were screened for osteoporosis and chronic periodontitis. Periodontal assessments included tooth loss, plaque index, probing depths, and clinical attachment levels. Statistically significant negative correlations were found between BMD and tooth loss and BMD and clinical attachment loss that were independent of plaque scores. In another study controlling for known confounders, the relationship between systemic bone mineral density and periodontal disease in 70 postmenopausal Caucasian women aged 51 to 78 was investigated. BMD was assessed by dual-energy x-ray. The severity of periodontal disease was represented by clinical attachment loss and interproximal
alveolar bone loss (ABL). It was found that Mean ABL and BMD are correlated with each other. Clinical attachment loss appeared to be related to skeletal bone mineral density consistently at all regions of the skeleton, but the results did not reach the level of statistical significance. For a 2-year longitudinal clinical study, the alveolar bone height and density changes in 21 osteoporotic/osteopenic women were compared with those of 17 women with normal lumbar spine BMD. These subjects were postmenopausal women having a history of periodontitis and participating in a periodontal maintenance program. The results indicated that osteoporotic/osteopenic women exhibited a higher frequency of loss in alveolar bone height and crestal bone density relative to women with normal BMD. However, these results should be interpreted with caution since the compared groups are small. Variety of methods used to assess osteoporosis and periodontitis, as well as varying definitions of outcomes of interest. If osteoporosis is a predisposing factor for periodontal tissue destruction, then a relationship should exist between measures of systemic bone mineral density and periodontal tissue destruction. However, previous studies have failed to establish a strong relationship. Possible explanations for this could be lack of precise methods for assessment of bone density and confounding of the result by other factors such as age, gender, smoking, remaining nature teeth, hormone intake, exercise of jaw bone, and most importantly the host susceptibility to dental plaque and oral hygiene status. Moreover, the cross-sectional studies have their own limitations, since little information is available about the pattern of disease progression during the short period of the study, nevertheless, most osteoporosis and periodontal disease progress in a chronic pattern. Although findings of these studies regarding the association between osteoporosis and periodontal disease are still controversial, with Increases in the number of aged patients in Taiwan society, the dialogue among medical and dental professional in this field provides a unique viewpoint in achieving and maintaining patients’ optimal health. Clearer understanding of this relationship may aid health care providers in their efforts to detect and prevent osteoporosis and periodontal disease. To date, few longitudinal studies have been performed. To better evaluate the relationship between bone mineral density and periodontal disease, additional prospective longitudinal studies with further analysis of possible confounding factors for osteoporosis and periodontal disease in larger cohorts of postmenopausal women are needed. However, dentists must bear in mind that the primary etiology of periodontal disease is pathogenic bacterial plaque in a susceptible patient. Therefore, if good oral hygiene is combined with regular check-ups, the effects that any of osteoporotic factors may exert on the periodontal tissues can be minimized.
RISK FACTORS FOR OSTEOPOROSIS AND PERIODONTAL DISEASES

Risk factors for osteoporosis can be divided into non-modifiable and modifiable (Table 1). The non-modifiable risk factors for osteoporosis include gender, age, early menopause, thin or small body frame, race, and heredity. Lack of calcium and vitamin D, lack of exercise, smoking, and alcohol consumption are modifiable risk factors. Low bone mass, certain medications, propensity to falling, and systemic diseases such as hyperparathyroidism and hyperthyroidism are modifiable to some extent.

Calcium-regulating hormones, disorders such as anorexia nervosa or bulimia, and genetic abnormalities may also play a role in decreased bone density.29

Bone loss in women occurs most rapidly in the years immediately following menopause when natural levels of estrogen are greatly reduced. In most women, bone mass reaches its peak in the third decade of life and declines30,31 thereafter. This decline in bone mass accelerates with the onset of menopause. While estimates of the rate of postmenopausal bone loss may differ by population and measurement technology, a rate on the order of 32,33 0.5% to 1.0% per year has been reported.

Table 1.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Modifiable</th>
<th>How Modifiable</th>
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<tbody>
<tr>
<td>Gender</td>
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<td></td>
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<tr>
<td>Age</td>
<td>No</td>
<td></td>
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<tr>
<td>Early menopause</td>
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MECHANISM OF ASSOCIATION BETWEEN OSTEOPOROSIS AND PERIODONTAL DISEASES

Mechanisms by which osteoporosis or systemic bone loss may be associated with periodontal attachment loss, loss of alveolar bone height and tooth loss is shown in Fig(1). First, low bone mineral
density in the oral bone may be associated with low systemic bone. This low bone density or loss of bone mineral density may lead to a rapid resorption of alveolar bone along with periodontal disease caused by periodontal bacteria as it intensifies the bone loss.

Second, systemic factors affecting bone remodeling may also modify local tissue response to periodontal infections. Individuals with systemic bone loss are known to have increased systemic production of cytokines (i.e. interleukin-1 and interleukin-6) that may have an effect on bone throughout the body, including the bones of oral cavity. Periodontal infection has been shown to increase the local cytokine production that, in turn, increases local osteoclast activity resulting in increased bone resorption.

Third, genetic factors that predispose a person to systemic bone loss also influence or predispose a person to periodontal destruction. Lastly, certain lifestyle factors such as cigarette smoking and suboptimal calcium intake, amongst others, may put individuals at risk for development of both osteopenia and periodontal disease\[^34\]. It has been hypothesized that osteoporosis may cause decreased alveolar bone density, which in turn, may be more susceptible to resorption by the effect of co-existing or subsequent periodontal infection and inflammation.

**IMPLICATION FOR THE TREATMENT OF PATIENT'S WITH OSTEOPOROSIS AND PERIODONTITIS**

Implications for treatment of patients with osteoporosis and periodontitis: Medications and strategies in current use for osteoporosis prevention and treatment include bisphosphonates, Selective Estrogen Receptor modulators (SERMs), calcitonin, Hormone Replacement Therapy (HRT) and Nutritional Supplements of Calcium and Vitamin D. Anti-resorptive medications: These groups of medications act on resorption phase without affecting the formation in osteoporosis. The bisphosphonates have been shown to prevent alveolar resorption and preserve mandibular bone mass in animals, but their exact role has not been clearly established in human studies. Also, the retention of teeth has been reported to be higher in patients on HRT\[^35\]. Nishida et al\[^36\] surveyed the dietary intake of calcium and periodontal examination on 12,000 adults.
It was found that there was inverse association between dietary calcium intake and level of periodontal disease, controlling for smoking and age.

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