

OSTEOPOROSIS AND PERIODONTAL DISEASE: AN UPDATE

LubnaTaj*, Khalid Almas**

*Former International Fellow in Advanced Periodontics. Division of Periodontology

**Division of Periodontology, University of Connecticut Health Center, School of Dental Medicine,
263 Farmington Ave. Farmington. CT 06030 USA.

ABSTRACT

The aim of the review is to evaluate the current status of relationship between osteoporosis and periodontal diseases. Now due to aging population in industrialized nations, osteoporosis is a common observation. Osteoporosis is the most common disease of middle-age and elderly people. Its main consequence is the increased risk of bone fractures and tooth loss. It is the thinning of bone tissue and loss of bone density over time. Osteoporosis is amongst the commonest chronic diseases in which bone becomes porous and more susceptible to fracture. It is estimated that one in three postmenopausal women and one in five men over the age of 50 years are affected. There are no symptoms in the early stages of the disease. Symptoms occurring late in the disease include bone pain or fracture. Osteoporosis may contribute to periodontal disease and ultimately tooth loss. Both of these diseases have been a public health concern because of the impact caused by bone fracture and tooth loss. Bone loss is a common feature of periodontitis and osteoporosis. The etiology of tooth loss is multifactorial, but one particular focus of interest has been whether osteoporosis is a contributory factor. Various researchers have addressed this question in studies of varying qualities. The weight of the evidence suggests that there is a significant relationship between the number of teeth present and skeletal bone mineral density.

In this article the plausible link has been reviewed between periodontal disease and osteoporosis. It is hoped that the review would help dental professionals to deliver better treatment and comprehensive oral care to their patients. Thus, the elderly could live a healthier and more meaningful quality of life with the prevention of these diseases.

Keywords: Osteoporosis, Osteopenia, Bisphosphonates, Periodontal attachment loss.

INTRODUCTION

According to World Health Organization (WHO), Osteoporosis is considered to be present when the bone mineral density (BMD) is 2.5 standard deviations below the normal. Osteopenia is defined as bone mineral density T-score between -1.0 and -2.5.¹ The clinical importance of systemic bone loss as a contributory factor to alveolar bone loss and subsequent loss of teeth requires to be studied extensively. Moreover the possibility that osteoporosis and periodontal diseases could be related because they share common etiological agents, which could affect

or modulate their natural history, should be looked into.^{2,3} There is a significant association between osteoporosis and tooth loss after adjusting the effect for age and smoking.⁴ Fractures resulting from osteoporosis can affect a patient's quality of life severely, and fractures result in functional impairment and increased health care cost and mortality. Medical management of osteoporosis includes diet control, with appropriate intake of calcium and vitamin D, weight-bearing exercise, discontinuation of tobacco and alcohol intake, and use of medications, including selective estrogen receptor modulators, calcitonin, anabolic agents and bisphosphonates.⁵

RISK FACTORS OF OSTEOPOROSIS

Non-modifiable risk factors

Osteoporosis is common after ages 35 and 40 in both sexes, with acceleration of bone loss within a decade after menopause in women.⁶ The proportion

Correspondence:

Prof. Khalid Almas

Division of Periodontology,
University of Connecticut Health Center,
School of Dental Medicine,
263 Farmington Ave. Farmington. CT 06030 USA.

Phone: 860-679-3721, Fax: 860-679-1027

E-mail: Almas@uchc.edu, Khalidalmas@yahoo.com

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of women with normal bone density declines sharply with increasing age.^{7,8} Women are more susceptible to osteoporosis than men. However, osteoporosis in men, particularly at an older age is an important health problem in the elderly.⁹ Genetics play an important role in regulating bone density, skeletal geometry, and bone turn over as well as contributing to the pathogenesis of the osteoporotic fracture as evidenced by hereditary studies.^{10,11}

MODIFIABLE RISK FACTORS

Gonadal hormones are the most important influence on bone loss in women. The onset of menopause and subsequent estrogen deficiency can affect the rate of bone loss.¹²⁻¹⁴ Rapid bone loss can be prevented by hormone replacement therapy.^{13,15,16} For regulation of bone mineral density in men, testosterone is considered to be of primary importance, though estrogen also appears to play a role at a later age in establishing peak bone mass and maintaining bone mineral density.¹⁷⁻¹⁸ Calcium intake is very important for skeletal growth and peak bone mass development.¹⁹ Increasing the intake of milk in adolescents has been shown to improve bone mineralization.²⁰ Calcium supplementation in post-menopausal women with low habitual dietary calcium intake may be effective in reducing bone loss.^{21,22} The body weight history of women with anorexia nervosa is the most important predictor of the presence of osteoporosis.²³ Therefore, all persons with eating disorders remain at increased risk for osteoporosis. Vitamin D is essential for optimal absorption of calcium. Deficiency in vitamin D contributes to osteoporosis and fractures through its effects on bone fragility and impaired muscle strength.²⁴ High consumption of fruits and vegetables, and the resulting high intake of dietary alkali have beneficial effects on bone mineral density.²⁵

Cigarette smoking is associated with low bone mineral density as well as increased risk for fractures in men and women. This effect will only slowly diminish after a person stops smoking.²⁶ Heavy alcohol consumption has been shown to depress osteoblast function and thus decrease bone formation. Lack of physical activity is associated with an increased risk of osteoporosis, whereas weight bearing and muscular activity stimulate bone formation and increase bone mass.²⁷ Low body weight and weight loss are both established risk factors for low bone mass and an increased rate of bone loss.^{28,29} Bone loss can also be

induced by medications, the most important of which are glucocorticoids.³⁰

DIAGNOSIS

BMD accounts for more than 75% of bone strength. Quantitating osteopenia to predict the risk of experiencing fractures is as useful as measuring blood pressure or cholesterol levels to predict the risk of experiencing stroke or myocardial infarction.³¹ Spine and hip BMD reflect the risk of experiencing vertebral and hip fractures. Dual energy x-ray absorptiometry (DXA) is considered the gold standard method for determining BMD. Peripheral BMD measures include peripheral DXA, calcaneal ultrasonography^{32,33} and digital x-ray radiogrammetry, and they are used for screening and to predict the short-term risk of experiencing fracture.^{34,35} The World Health Organization (WHO) defines osteoporosis in postmenopausal women as a BMD with T score more than 2.5 standard deviations below the mean for young healthy adults. A BMD between 1.0 and 2.5 standard deviations below the mean (T score = "1.0 to -2.5) is classified as osteopenia.³⁶

PREVENTION AND TREATMENT

Pharmacological options for osteoporosis prevention and treatment are, Hormone Replacement Therapy, Alendronate, and Raloxifene for prevention, and Calcitonin for treatment.³⁷ Clinicians, including dentists, should inform and motivate the public to make and sustain life style changes relating to exercise, diet, tobacco, and alcohol use. The National Osteoporosis Foundation as well as the National Academy of Sciences recommends a daily intake of 1200 mg of dietary calcium and 400-800 IU of vitamin D.

Tobacco use should be discouraged and current smokers should be encouraged to quit on their own or participate in smoking cessation programs. Counseling and treatment should be offered to patients with excessive alcohol consumption as part of the life style modifications to prevent osteoporosis.³⁸ The beneficial effects of physical activity and weight bearing exercises have been well documented.^{39,40,41}

PHARMACOLOGICAL INTERVENTION

Several pharmacological agents are available to increase bone mineral density and therefore treat or prevent osteoporosis. They include hormone replace-

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ment therapy, bisphosphonates, calcitonin, selective estrogen receptor modulators, parathyroid hormone or combination of these medications. There is sufficient evidence in the literature to demonstrate that depending on the drug and the patient population, treatment reduces the risk of vertebral fractures by 30-65% and non-vertebral fractures by 46-53%.^[42]

HORMONE REPLACEMENT THERAPY (HRT)

Rapid loss of bone density is observed because of estrogen deficiency in the early post-menopausal years. The rationale for HRT is to delay this bone loss. Estrogen therapy can inhibit osteoclast formation and function and can also extend the lifespan of osteoblasts and osteocytes.⁴³ In a randomized clinical trial as part of the women's health initiative trial, women were randomly assigned to receive conjugated estrogens, with or without a progestin, the reduction in hip fractures was 33%.⁴⁴ HRT increased total hip bone density and reduced the risk of fractures at the hip, vertebrae and wrist.⁴⁵ Discontinuation of estrogen results in measurable bone loss, although it is not certain whether discontinuation results in a greater fracture risk than continuation.⁴⁶

Recently, concern has been raised about the non-skeletal risks associated with long term use of estrogen. Evidence of an increased risk of breast cancer and of cardiovascular outcomes during the course of the estrogen plus progestin trial of the women's health initiative prompted early termination of this trial in 2002.⁴⁴

This has led to a re-evaluation of the role of HRT in the treatment and prevention of osteoporosis. HRT should not be recommended for prevention of osteoporosis in post-menopausal women, unless the woman are at a significant risk of osteoporosis, and other osteoporosis medications are unable to be considered.⁴⁷ It is therefore important that women discontinuing HRT receive appropriate screening for their risk for complications of osteoporosis and should be counseled regarding alternative forms of therapy to prevent fracture.⁴⁸

SELECTIVE ESTROGEN RECEPTOR MODULATORS

They were developed to provide the benefits of estrogen therapy without its unwanted side effects.

Their mechanism of action such as that of raloxifene is similar to that of the estrogens.⁴⁹ Reduction in fractures was observed in the first year of treatment but no effect was found on the risk of non-vertebral fractures. Adverse effects include hot flashes and cramps. Similar to estrogen therapy, an increase in the incidence of deep vein thrombosis was observed.⁵⁰ New selective estrogen- receptor modulators are being researched and may be available in the near future.

BISPHOSPHONATES

They are analogues of pyrophosphate and bind selectively to bone mineral. During bone resorption they are taken up by the osteoclast, resulting in osteoclast de-activation and apoptosis⁷. Bone resorption is suppressed followed by a secondary mineralization resulting in increased bone mass, improving bone strength and a reduction in fractures.⁵¹

Bisphosphonates are often considered the first-line therapy for the treatment of post-menopausal osteoporosis. They are the most widely prescribed anti-restorative agents. Randomized trials of alendronate and risedronate, two second generation bisphosphonates, demonstrated increased bone mineral density in post-menopausal women with osteopenia or osteoporosis. In women with osteoporosis a reduction in the incidence of hip, vertebral and non-vertebral fractures of nearly 50% was found. This effect was noted early in therapy. Osteonecrosis of the jaws occurs more commonly in the mandible but has also been reported in the maxilla, and appears to be highly associated with periodontitis, other oral infections, and extraction of the affected teeth in majority of the reported cases. In addition the signs and symptoms that may occur before the appearance of clinically evident osteonecrosis include changes in the health of the periodontal tissues, non-healing mucosal ulcers, loose teeth and unexplained soft tissue infection. The role of oral bisphosphonates in osteonecrosis of the jaw needs to be further evaluated.⁵²⁻⁵⁵

CALCITONIN

Calcitonin is an inhibitor of osteoclast activity. Both nasal and subcutaneous calcitonin are available for treatment of post-menopausal osteoporosis. Treatment of women with osteoporosis with nasal calcitonin has been shown to reduce the incidence of vertebral fractures in a single randomized study, by 33% when compared to placebo.⁵⁶

**COMMON RISK FACTORS OF
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DISEASE**

Periodontitis or periodontal disease is an inflammatory process characterized by loss of connective tissue and alveolar bone. It is generally accepted that the single, most important, etiological factor in periodontitis is subgingival dental plaque with its concurrent bacterial infection, leading to loss of epithelial attachment and loss of alveolar bone.^{57,58} Like osteoporosis, it is a silent disease, being asymptomatic until late when mobile teeth, abscesses and tooth loss may occur. In addition, periodontitis and osteoporosis have several risk factors in common (Table 1).

Two recent review articles on osteoporosis and periodontal disease discussed a number of issues regarding general BMD and oral alveolar bone loss, early loss of teeth and increased severity of periodontal disease in patients with osteoporosis.^{60,61} Risk factors for osteoporosis such as smoking, old age, and low intake of calcium and vitamin D also are common in patients with advanced periodontal disease. Conducting clinical and radiographic dental examinations, as

well as recognizing common risk factors for both osteoporosis and periodontal disease, can help dentists identify patients who are at risk of developing osteoporosis. The results of an assessment of an alveolar trabecular pattern can be a clinical indicator of BMD.⁶²

The results of other studies suggest that routine panoramic radiographs also can be used to detect low BMD, osteoporosis and risk of experiencing vertebral fracture in postmenopausal women.^{63,64} The results also showed that providing special training to general practitioners in how to use specific evaluation techniques to read the panoramic radiographs enhanced their detection of significant radiographic changes. In short, the mandibular inferior cortex can show changes that vary from normal when the endosteal cortical margins are even and sharp on both sides, to mild or moderate erosion of the inferior cortex, to severe erosion and presence of heavy endosteal cortical residues and porosity of the inferior mandibular cortex.⁶⁵ This procedure can help detect a high percentage of postmenopausal women with undetected low BMD, as well as undetected spinal fractures.^{64,65}

Table 1: Risk factors for osteoporosis and periodontitis.^[59]

Osteoporosis	Common	Periodontitis
Female gender	Tobacco	
Caucasian or Asia	Poor nutritional status	Bacterial dental Plaque
Genetics	Advanced age	Stress
Menopause	Glucocorticoid therapy	
Diabetes		
Hypogonadism	Immunological diseases, Pregnancy	
Hyperparathyroidism		
Hyperthyroidism		
High protein intake		
Low vitamin D or calcium intake		
Alcohol abuse		
Sedentarism		
Low peak bone mass		
Drugs: heparin		
Low weight		

Oral (alveolar) bone health and Osteoporosis

There is increasing evidence 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 evidence including several prospective studies supports an association of osteoporosis with the onset and progression of periodontal disease in humans. The majority of studies have shown low bone mass to be independently associated with loss of alveolar crestal height and tooth loss. However studies that focus on the relation of clinical attachment loss and osteoporosis are less consistent. To date, the majority of studies on the relationship between periodontal disease and osteoporosis have been hindered by small sample sizes, limited control of other potential confounding factors, varying definitions of both periodontal disease and osteoporosis, and few prospective studies where the temporality of the association can be established. Potential mechanisms by which host factors may influence onset and progression of periodontal disease directly or indirectly include underlying low bone density in the oral cavity, bone loss as an inflammatory response to infection, genetic susceptibility, and shared exposure to risk factors. Systemic loss of bone density in osteoporosis, including that of the oral cavity, 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 incidence and severity.⁶⁶

Tezal et al.,⁶⁷ studied 70 postmenopausal Caucasian women aged 51 to 78 years. They concluded that skeletal BMD is related to interproximal alveolar bone loss and, to a lesser extent, to clinical attachment loss, implicating postmenopausal osteopenia as a risk indicator for periodontal disease. Recently Al Habashneh et al.⁶⁸ in their cross-sectional study of 400 Jordanian postmenopausal women (mean age 62.5 yrs) reported that osteoporosis was significantly associated with severe alveolar crestal bone loss and the prevalence of periodontitis. In another recent study by Sultan and Rao⁶⁹ on 80 dentate Goan postmenopausal women (age >50 yrs), it was concluded that skeletal BMD is related to interproximal alveolar bone loss (ABL) and clinical attachment loss (CAL), though not to a statistically significant level; implicating post-

menopausal osteopenia as a risk indicator for periodontal disease.

Physicians and dentists have a mutual interest in identifying patients at risk of developing osteoporosis and periodontal disease. Collaboration between these professionals in the prevention and early diagnosis of osteoporosis, low BMD and fractures can lead to early osteoporosis therapy. In the future, it will be important to recognize if patients with osteopenia and osteoporosis who are receiving medical treatment respond better to treatment and control of bone diseases in the head and neck region. Further studies should also consider the prior selection of a precise measurement of periodontal disease to establish a strong association between osteoporosis and periodontal disease.

CONCLUSION

Recent epidemiological and clinical data provides limited but convincing evidence suggesting a positive association between osteoporosis and periodontal disease, and many common risk factors could have been detected in the etiology of both diseases.

1. Physicians and dentists collaborate to improve early detection of patients at risk of experiencing or who have osteoporosis. All health care professionals involved in the care of dental patients, particularly patients who are taking oral bisphosphonates, should discuss patient care decisions and informed consent should be obtained.
2. The proper knowledge of the level of participation of many systemic factors in the etiology of periodontal disease is still in infancy and Osteoporosis is one of those factors. Further comprehensive multicenter research is needed to definitely prove or disprove the association of osteoporosis in the etiology of periodontal disease.
3. Although a positive association between osteoporosis and periodontal disease was found, and despite the incipient evidence linking osteoporosis and periodontitis, additional studies are needed to elucidate this topic. These might include different study design, possibly with intervention before menopause, with long-term follow up, and investigation of oral conditions during the postmenopausal phase.

It is hoped that this review would be helpful for health care professionals in the prevention, early detection, and treatment of these common diseases. Better understanding of osteoporosis and patients with periodontal diseases, would certainly help to improve their quality of life.

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