Review Article

Relationship Between Osteoporosis and Periodontal Disease: Review of the Literature

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Abstract

Objective: Osteoporosis is a skeletal disease characterized by reduction in bone mass and micro architectural changes in the bone, which leads to increased bone fragility. The gold standard for the diagnosis of osteoporosis is the measurement of bone mineral density (BMD) by dual energy x-ray absorptiometry (DXA). Periodontal disease is a chronic destructive disease which can occur in adults, young people and children. Periodontal pathogens cause inflammation of the gingiva which is called gingivitis. When periodontal tissue destruction and alveolar bone loss happen, it is called periodontitis. Since both osteoporosis and periodontal diseases are bone destructive diseases, it has been hypothesized that osteoporosis could be a risk factor for the progression of periodontal disease. The aim of this study is to review the articles assessing the relationship between osteoporosis and periodontitis

Materials and Methods: In this review, articles were selected from PubMed between January of 1998 and June 2010. Amongst 508 articles identified from the electronic search, 17 articles were selected for a full-text reading based on the inclusion and exclusion criteria.

Results: Among the 17 studies focused on, 11 studies showed a positive relation between osteoporosis and periodontal disease and the six remaining studies found no significant relation between osteoporosis and periodontal disease.

Conclusion: These data indicate a greater propensity to lose alveolar bone in subjects with osteoporosis, especially in subjects with preexisting periodontitis. This would indicate that osteoporosis or low systemic BMD should be considered a risk factor for periodontal disease progression.

Key Words: Periodontitis; Tooth Loss; Bone Density; Osteoporosis

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INTRODUCTION

Osteoporosis is a skeletal disease characterized by reduction in bone mass and micro architectural changes in the bone, which leads to an increased bone fragility and an increased risk of fracture [1]. Osteoporosis results from an

imbalance between the rate of bone formation and resorption that leads to loss of bone mineral mass. Loss of the mineral component of the bone leads to a greater tendency of the bone to be broken.

The consequences of fracture in elderly people include an increased risk of death, long-term nursing home care or permanent limitations in mobility and performance of daily living activities.

Many of the risk factors for osteoporosis are environmental and therefore, are preventable. Established risk factors include older age; female gender; postmenopause; Caucasian or Asian race; a low body mass index; cigarette use; alcoholism; inadequate calcium and vitamin D intakes; physical inactivity; taking medications such as glucocorticoids and anticonvulsants; and anorexia nervosa [2,3]. Although osteoporosis and osteopenia can affect people of all ages, they occur most often in middle-aged and elderly people [4].

Conventional radiography is not sensitive enough to diagnose osteoporosis, until the total bone density has decreased by 50% [5]. At this time, the gold standard for osteoporosis diagnosis is the measurement of bone mineral density (BMD) by dual energy x-ray absortiometry (DXA) [6].

DXA uses an x-ray source for BMD measurement and the measurement is expressed as "area density" in units of grams/cm^2 [7]. The World Health Organization defines osteoporosis as a bone density score greater than 2.5 standard deviations below the young adult mean in a female population aged 20 to 40 years. A bone density score between 1 and 2.5 standard deviations below the mean is termed osteopenia or low bone mass [6].

Osteoporosis is categorized into primary or secondary. Primary osteoporosis is associated with increased age and/or decreased sex hormones. Secondary osteoporosis implies an underlying cause such as usage of glucocorticoids, systemic diseases affecting bone turnover, or low calcium intake [8, 9].

Periodontal disease is a chronic destructive disease that may occur in adults, young people and children. Periodontal pathogens which are found in the dental biofilm result in inflammation of the gingiva which is called gingivitis. When periodontal tissue destruction and alveolar bone loss happen, it is called periodontitis [11,12]. Periodontal disease and periodontal pathogen have been linked to several systemic diseases [10]. There are many factors mentioned as periodontal risk factors such as gender, [11] tobacco use, diabetes and nutrition [13], body mass index [BMI] [14], socioeconomic status and access to dental care [15]. By the way, it seems that some systemic conditions such as cardiovascular disease, diabetes mellitus, preterm birth, osteoporosis, respiratory disease and systemic infections are related to the periodontal status [16-23]. Recently, some studies have reported an association between osteoporosis and bone loss in periodontal diseases. Discussions about the association between these two bone-damaging diseases began in 1960. [24] Since both osteoporosis and periodontal diseases are bone destructive diseases, it has been hypothesized that osteoporosis could be a risk factor for the progression of periodontal disease. But some of the literature concluded that osteoporosis in human organs has no effect on the maxilla and mandible density. The aim of this study is to review the articles assessing the relationship between osteoporosis and periodontitis.

MATERIALS AND METHODS

To review the association between periodontal disease and osteoporosis five steps were undertaken.

An electronic search was performed using MEDLINE, PubMed, from January of 1998 to June 2010.

Step1. First the appropriate terms were extracted from articles, books and especially from "MESH" database in the site "Pubmed". These terms were as follows:

1. Periodontal disease and osteoporosis

2. Periodontal disease and body mass index
3. Periodontal disease and osteopenia
4. Periodontal disease and reduction in bone density
5. Periodontal disease and body bone fracture

Step 2. Then the terms were searched separately. In this step, 508 articles for periodontal disease and osteoporosis terms, 287 articles for periodontal disease and body mass index, 528 articles for periodontal disease and osteopenia terms, 80 articles for periodontal disease and reduction in bone density terms and finally 18 articles for periodontal disease and body bone fracture terms were found.

Step 3. The titles of articles were reviewed and the appropriate ones were selected. In this step, 115 articles were selected.

Step 4. Reviewing the abstracts and selecting the articles based on the inclusion and exclusion criteria. In this step, 17 articles were selected. Inclusion criteria were all the articles which directly evaluated the relation between periodontal disease and osteoporosis. Exclusion criteria were as follows:

1. Studies which did not directly evaluate the relation between periodontal disease and osteoporosis.
2. Studies that were in the form of case series and case reports.
3. Studies that examined fewer than 10 patients.

Step 5. Reviewing the full text of the 17 selected articles and extracting relevant information.

To categorize data, the included studies were ranked according to their design and sample size. Using these criteria, scientific validation was determined as follows:

Scientifically and Clinically Validated (SCV):

•Systematic reviews of randomized clinical trials (RCTs) or

•Two or more RCTs + ≥ 100 patients or

•One RCT and two or more prospective studies + ≥150 patients

Clinically Well Documented (CWD):

•One RCT and two or more prospective studies + ≥50 patients or

•No RCTs, but at least three prospective studies + ≥50 patients or

•No RCTs, but two or fewer prospective studies + ≥100 patients

Clinically Documented (CD):

•No RCTs, at least two prospective + any retrospective studies + ≤ 40 patients– or

•No RCTs, retrospective studies + ≥ 60 patients

Clinically Insufficiently Documented (CID):

•None of the above, expert opinion only

LITERATURE REVIEW

The clinical importance of systemic bone loss as a risk factor to alveolar bone loss and tooth loss requires to be studied extensively. Moreover, osteoporosis and periodontal diseases could be related because they share common etiological agents, which could affect or modulate their natural history and should be looked into [4].The following section will review 17 Studies on the association between periodontal disease and osteoporosis.

Kribbs et al. [25] were the first to address the association between periodontal disease and osteoporosis. They compared the mandibular bone mass of 85 osteoporotic women and 27 normal women and reported the osteoporotic group had less mandibular bone mass and density and a thinner cortex at the gonion than the normal group. No differences in clinical periodontal measurements were found between osteoporotic and normal groups [Odds ratio (OR): 2.7 (95% CI: 1.1-6.5)]. Von Wowern et al. [26] measured mandibular bone mineral content by dual photon absorptiometry in 52 women with a history of osteoporotic fracture and concluded that osteoporotic subjects did not have less bone mineral content in their jaw bones [OR: 1.00 (95% CI: 0.98-1.02)].Jacobs et al. [27] designed a longitudinal study which assessed lumbar spine BMD of 69 women receiving hormone replacement therapy, up to

Table 1. Studies Showing a Positive Association between Osteoporosis and Periodontal Disease

Author	Population	Study Design	Risk Estimate	Result
Kribbs et al. (25)	85 osteoporotic women and 27 normal women	Cross-sectional	OR: 2.7 [95% CI: 1.1-6.5]	Osteoporotic group had less mandibular bone mass and density
Jacobs et al. (27)	69 women receiving HRT aged 32-64 at entry	Prospective longitudinal study	No OR calculated	Positive correlation between spinal density and mandibular bone mass at the second examination (average follow-up 5.1 years)
Streckfus et al. (28)	28 healthy women aged 23 women with periodontitis	Cross-sectional	OR: 2.74 [95% CI: 1.23-6.12]	More ABL, more missing teeth, in postmenopausal women with estrogen deficiency
Southard et al. (29)	61 dentate Caucasian women aged 20 to 78 years	Cross-sectional	OR: 5.3 [95% CI: 2.5-11.3]	Significant correlation between the density of maxillary and mandibular alveolar process, lumbar spine, hip and radius
Jeffcoat et al. (31)	158 postmenopausal women	Cross-sectional	OR :5.23	Significant correlation between hip BMD and mandibular basal BMD
von Wowern et al. (36)	112 women with osteoporotic fractures	Cross-sectional	OR: 2.7 [95% CI: 1.1-6.5]	Greater amounts of loss of attachment in osteoporotic women with a mean age of 68
Tezal et al. (37)	70 postmenopausal Caucasian women aged 51–78	Cross-sectional	OR :2.89	Mean ABL was significantly correlated with systemic BMD
Payne (38)	41 with normal BMD, 17 osteoporotic women	2-year prospective longitudinal clinical study	OR: 1.73 [95% CI: 1.23-2.43]	Greater ABL, crestal and subcrestal density loss in the osteoporotic and estrogen-deficient women.
Reinhardt et al. (39)	Women within 5 years of menopause, 59 with adult periodontitis and 16 non-periodontitis. Stratified by serum estradiol level	2-year prospective longitudinal study	OR: 1.68	In non-smoking osteopenic/ osteoporotic periodontitis patients with estrogen deficiency had more bleeding on probing and clinical attachment loss
Taguchi et al. (40)	64 women between the ages of 50 and 70 years	Cross-sectional	OR: 2.10	Mean alveolar bone level significantly correlated with systemic BMD
Grodstein et al. (41)	42,171 post-menopausal women	Cross-sectional	OR: 1.35 [95% CI: 1.14-1.59]	Significant correlation between systemic BMD and mandibular basal BMD

5 years with dual photon absorptiometry of the lumbar spine.

After 5 years, a positive effect of estrogen replacement therapy on the bone mass of the mandible and the lumbar spine was observed and they suggested that mandibular bone mass correlated with bone mass in the spine and the wrist. No OR was calculated.

Streckfus et al. [28] designed a quantitative factor for measurement on vertical dimension and hand radiographs in 28 healthy women aged and 23 women with periodontitis. Based on the results, they concluded that postmenopausal women on estrogen therapy had more alveolar bone loss (ABL), more missing teeth, and reduced alveolar and second metacarpal bone density than premenopausal women [OR: 2.47 (95% CI: 1.23-6.12)]. Southard et al. [29] used quantitative intraoral radiography and systemic bone densities determined by dual-energy X-ray absorptiometry (DXA) in 61 Caucasian women. They found significant correlation between the density of maxillary and mandibular alveolar process, lumbar spine, hip and radius in healthy women [OR: 5.3 (95% CI: 2.5-11.3)]. Shrout et al. [30] selected 65 postmenopausal women who had no or only mild periodontal disease (no probing depths > 5 mm) and compared the complexity of the trabecular pattern of their digital bitewings with the lumbar spine and femoral BMD. They found weak relation between the complexity of the trabecular pattern of lumbar spine and femoral BMD [OR: 1.16 (95% CI: 0.90-1.49)].

Leffcoat et al. [31] in a preliminary report of the study of the Women's Health Initiative, evaluated 158 postmenopausal women. The women's hipbone mineral density was confirmed by DXA and the mandibular bone density was measured by quantitative digital radiography. After data adjustment, a significant correlation was found between mandibular basal bone and hipbone mineral density (OR: 5.23). Elders et al. [32] compared the clinical parameters of periodontitis and alveolar bone height with BMD of the lumbar and metacarpal bone. No statistically significant differences were observed in gingival bleeding, probing pocket depths, gingival recession and marginal bone level of the subjects with low BMD compared to subjects with high BMD [OR: 1.46 (95% CI: 0.97-2.21)].

Hildebolt et al. [33] designed a study to answer the question," is clinical attachment loss related to BMD?". They assessed BMD of 135 postmenopausal women aged 41-70 years, with no moderate to severe periodontitis and reported that attachment loss was correlated with tooth loss, but not with BMD [OR: 1.4 (95% CI: 0.6-3.1)]).

When Weyant et al. [34] compared the number of attachment loss sites with systemic BMD in 292 women, no statistically significant association was found between periodontal disease and systemic BMD [OR: 1.56 (95% CI: 0.98-2.02)]. Lundstrom et al. [35] compared 15 women with osteoporosis to 41 subjects with normal BMD. No statistically significant differences were found in gingival bleeding, probing pocket depths, gingival recession, or the marginal bone level between the women with osteoporosis and the women with normal BMD [OR: 1.3 (95% CI: 0.98-1.02)].

Von Wowern et al. [36] assessed 112 women with osteoporotic fractures and found greater amounts of loss of attachment in osteoporotic women with a mean age of 68 [OR: 2.7 (95% CI: 1.1-6.5)].

Tezal et al. [37], in a study assessed 70 postmenopausal Caucasian women's skeletal systemic BMD by DXA and reported that the mean alveolar bone level significantly correlated with systemic BMD and a correlation between clinical attachment levels and BMD was found (OR: 2.89).

Payne [38] evaluated 58 menopause periodontal patients which were in maintenance program. Forty-one of the patients had normal BMD and 17 women were osteoporotic. They reported greater alveolar bone loss, crestal and

subcrestal density loss in the osteoporotic and estrogen-deficient women [OR: 1.73 (95% CI: 1.23-2.43)]. Reinhardt et al. [39] assessed bleeding on probing and clinical attachment levels in 59 women with periodontitis and 16 non-periodontitis women, all within 5 years of menopause and reported osteoporotic periodontitis patients with estrogen deficiency had more bleeding on probing and clinical attachment levels (OR: 1.68). Taguchi et al. [40] evaluated 64 women between the ages of 50 and 70 years. Osteoporotic signs consisted of thoracic spine fracture and periodontal disease signs were the number of teeth present, mandibular cortical width and alveolar bone resorption. According to thes study results, they concluded that the mean alveolar bone level significantly correlated with systemic BMD (OR: 2.10).

Grodstein et al. [41] examined the risk of tooth loss in relation to hormone use in a prospective study of 42,171 post-menopausal women and reported the risk of tooth loss was lower in women who currently used hormones [OR: 1.35 (95% CI: 1.14-1.59)].

According to the above validation criteria, the level of evidence of the articles we reviewed regarding the association of periodontal disease and osteoporosis resulted in 3 prospective and 14 cross-sectional studies, is placed in the Clinically Well Documented (CWD) category.

RESULT

The results of this review are summarized in Tables 1 and 2.

The association between osteoporosis and periodontal disease has been evaluated in several studies.

Table 2. Studies Showing No Positive Association between Osteoporosis and Periodontal Disease

Author	Population	Study Design	Risk Estimate	Result
Von Wowern et al. (26)	52 women with osteoporotic fractures	Cross-sectional	OR: 1.00 [95% CI: 0.98-1.02]	Osteoporotic subjects had not less bone mineral content in their jaw bones
Shrout et al. (30)	65 postmenopausal women with no or mild periodontitis	Cross-sectional	OR: 1.16 [95% CI: 0.90-1.49]	Complexity of the trabecular pattern weakly correlated with lumbar spine and femoral BMD
Elders et al. (32)	216 females between 46 and 55 years	Cross-sectional	OR: 1.46 [95% CI: 0.97-2.21]	No significant correlation was observed between probing depth, bleeding on probing, missing teeth, alveolar bone height and bone mass
Hildebolt et al. (33)	135 postmenopausal women aged 41–70 years, no moderate, severe periodontitis	Cross-sectional	OR: 1.4 [95% CI: 0.6-3.1]	Attachment loss was correlated with tooth loss but not with BMD.
Weyant et al. (34)	292 dentate women (average age 75.5 years)	Cross-sectional	OR: 1.56 [95% CI: 0.98-2.02]	No statistically significant association between periodontal disease and systemic BMD
Lundstrom et al. (35)	15 women with osteoporosis, 41 women with normal BMD	Cross-sectional	OR: 1.3 [95% CI: 0.98-1.02]	No statistically significant differences in gingival bleeding, probing pocket depths, gingival recession and marginal bone level

Among the 17 studies focused on, 11 studies showed a positive relation between osteoporosis and periodontal disease and the six remaining studies found no significant relation between osteoporosis and periodontal disease.

DISCUSSION

Osteoporosis is a multi-factorial disease that reduced physical activity, poor nutrition, inadequate calcium intake and consuming too much alcohol and smoking are some of the risk factors.

The effect of osteoporosis in women is obvious, because in the post menopausal period, due to estrogen deficiency, bone structure is reduced and changed. Many of these changes ultimately lead to bone loss and osteopenia or in more severe mode lead to osteoporosis.

On the other hand, due to hormonal changes during this period, women are more susceptible to periodontal diseases. Especially, if not met in this period of oral health, women show an increased risk of periodontitis.

According to the review of literature, Kribbs et al. [25], Jacobs et al. [27], Streckfus et al. [28], Southard et al. [29], Jeffcoat et al. [31], von Wowern et al. [36], Tezal et al. [37], Payne [38], Reinhardt et al. [39], Taguchi et al. [40], Grodstein et al. [41] showed a positive association between osteoporosis and periodontal disease. On the other hand, in studies performed by Von Wowern et al. [26], Shrout et al. [30], Elders et al. [32], Hildebolt et al. [33], Weyant et al. [34], Lundstrom et al. [35] no positive association was detected between osteoporosis and periodontal disease.

In fact, osteoporosis cannot be a definitive factor in the understanding of periodontal disease. Since periodontal diseases are multifactorial and the main factor is microbial plaque. In fact, osteoporosis cannot be the cause of the onset of periodontal disease, but after outbreak of the disease, it may be a predisposing factor in the exacerbation, or persistence of the disease.

CONCLUSION

These data indicate a greater propensity to lose alveolar bone in subjects with osteoporosis, especially in subjects with preexisting periodontitis. This would indicate that osteoporosis or low systemic BMD should be considered a risk factor for periodontal disease progression. With the limitation of this review, it is clear that longer studies with more patients are needed on this issue.

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