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# Is there any association between systemic bone mineral density and clinical manifestations of periodontal disease?

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## *Abstract*

***Background and aims.*** The aim of the present study was to assess the hypothesis that an osteopenic diathesis may accelerate or exaggerate periodontal disease via evaluation of the clinical association between systemic bone mineral density and periodontal disease.

***Materials and methods.*** The subjects included 150 patients (mean age ≥ 45 years old) who were referred for evaluation of bone mineral density. After measurement of body mass index, skeletal bone mineral density (BMD) was assessed by Dual energy X-ray Absorptiometry (DXA) at femur and lumbar spines. Seventy five patients with lower than normal BMD values (49: Osteopenic, 26: Osteoporotic) were allocated into the case group and the rest of the subjects with normal BMD were allocated into the control group. Periodontal examination involved clinical probing depth (CPD), clinical attachment level (CAL), bleeding on probing (BOP), tooth mobility and the number of remaining teeth. The data were analyzed using chi-square test and student's t-test.

***Results.*** There was no significant difference with respect to CPD, BOP, the number of remaining teeth, and tooth mobility between case and control groups. However, clinical attachment loss in subjects of the case group was significantly higher than the control group.

***Conclusion.*** Although it was not possible to demonstrate a causal relationship between bone mineral density and clinical attachment loss in the periodontium, it appears that these two parameters are strongly correlated.

***Key words:*** **Bone mineral density, periodontal disease, clinical attachment loss, bone loss.**

## *Introduction*

Osteoporosis is a disease characterized by generalized bone resorption throughout the body which usually affects elderly women. The diseased sites are at increased risk of fracture, so that in the developed countries nearly one third of individuals aged more than 65 years exhibit signs of osteoporosis-related fracture.[1]

Alveolar bone loss is an integrated element of periodontal diseases leading to diminished tooth support. Therefore, it seems plausible to consider severe cases of osteoporosis as a negative contributory factor, accelerating or possibly exaggerating alveolar bone loss.[2] Further supporting evidence comes from studies evaluating the velocity of bone loss following extraction of teeth in normal and osteoporotic jaws. Osteoporosis accelerates post-extraction alveolar bone resorption by affecting certain stages of resorption.[3]

Kribbs et al. demonstrated that in osteoporotic women, the total body calcium was correlated with bone mineral density of the mandible.[4] Subsequent studies revealed that osteoporotic women, in comparison to normal subjects, exhibited lower mandibular bone density and thinner cortex in the mandibular angle. Moreover, tooth loss was the most frequent finding in osteoporotic women.[5] Elder et al. investigated the association between systemic bone mineral density and periodontitis (an inflammatory disease of the supporting tissues of the teeth) in 286 female subjects aged between 45-55 years. The results showed that there was no difference in bone mineral density (BMD) of lumbar spine and metacarpal cortical thickness (MCT) in edentulous and normal subjects. In addition, BMD of mandible and alveolar bone height (determined radiographically) were not correlated.[6]

Von Wovern et al. conducted a study of 12 osteoporotic women with previous history of fracture and 14 normal subjects. Periodontal status was examinedby measuring plaque index (PI) scores, bleeding on probing (BOP), and clinical attachment loss (CAL).[3] BMD of mandible and femoral bones were assessed using dual photon scanning. The results showed that osteoporotic subjects exhibited lower BMD in the mandibular and femoral bones compared to normal subjects. Although there was no difference in PI and BOP between the groups, CAL scores in the case group (osteoporotic subjects) were consistently higher than the control group.

It has been suggested that in individuals with higher BMD, teeth with deep periodontal pockets have a more favorable prognosis,[7] although there is still controversy in this regard. Hildebolt et al. suggested that alveolar bone resorption is only correlated with tooth loss, and not with spinal/femoral BMD.[8] Tezal et al. reported that alveolar bone loss and systemic BMD showed a positive correlation in the interdental areas.[9] They did not identify an association between attachment loss and systemic BMD. Jeffcoat et al. demonstrated a strong association between pelvic BMD and BMD of mandibular basal bone.[10] Lundstrom et al. did not find an association between systemic BMD and BOP, probing depth, gingival recession, and marginal bone level.[11]

Higher prevalence of both osteoporosis and periodontal diseases is parallel with the increased population of geriatric patients; this increases the possibility of concurrence of these two pathological entities.[12] Moreover, the extant relative disagreement of the findings enhances the difficulty of clinical decision-making.[13] The aim of the present study was to evaluate the association between systemic bone mineral density and periodontal indices of health.

## *Materials and Methods*

### *Study population*

150 patients (mean age $\geq$ 45 years old) who were referred for evaluation of bone mineral density were included in the present cross-sectional study. A history of the following items was ruled out: existence of systemic diseases, consumption of antacid medications/lithium/contraceptives, habitual use of cigarettes/alcohol/coffee, and history of periodontal therapy during the previous six months. Subjects were divided into two groups of gingivitis and periodontitis. In the gingivitis group, subjects presented with signs of gingival inflammation (positive bleeding on probing) without clinical attachment loss and lack of radiographic bone loss. Subjects in the periodontitis group presented with clinical attachment loss of more than 3mm detected around three or more teeth in at least two sextants.

### *Study procedure*

After measurement of body mass index, skeletal bone mineral density (BMD) was assessed by Dual energy X-ray Absorptiometry (DXA) at femur and lumbar spines. Seventy five Patients with lower than

normal BMD values (Osteopenic: 49, Osteoporotic: 26) were allocated into the case group, while the remaining subjects with normal BMD were allocated into the control group. Patients subsequently underwent periodontal examination, which included clinical probing depth (CPD), clinical attachment level (CAL), bleeding on probing (BOP), tooth mobility and the number of remaining teeth.

Information regarding the study and the surgical procedures were explained to the patients, and written consent was obtained from all of the subjects. This study was approved by the ethics/research committee of Tabriz University of Medical Sciences.

Plaque index (PI) was measured according to the O'Leary index.[14] In this method, the subjects used a disclosing agent, and after thoroughly rinsing the mouth, the number of colored tooth surfaces (except the occlusal surface) was recorded. PI was calculated as the product of colored tooth surfaces divided by all of the surfaces.

Clinical probing depth (CPD) was measured meticulously (in order to avoid invading the junctional epithelium) using a standard William's periodontal probe. Six regions in each tooth were examined for CPD: mesiobuccal, buccal, distobuccal, mesiolingual, lingual, distolingual. For examination of CAL, the distance between cementoenamel junction and the base of the periodontal pocket was measured in the buccal aspect of the teeth.

Bleeding on probing was measured as suggested by Ainamo & Bay.[15] The probe was gently moved while maintaining contact with the internal wall of the pocket. BOP was scored as positive if it was present 10 seconds after probing of the area. The grade and direction (horizontal/vertical) of mobility was measured by holding the tooth between two solid instruments (using a mirror handle) andapplying a gentle mechanical force.

All clinical measurements were recorded by a single examiner who was blind to the study design and groupings. The data were analyzed using chi-square test and student's t-test.

### *Results*

The age of the 150 patients ranged from 45 to 73 years (mean age: 52.87 ±7.71); 72.7% (109 subjects) were female, and 27.3% (41 patients) were male.

Based on the results of the periodontal examination, subjects were categorized into periodontitis or gingivitis groups. The occurrence of periodontitis in both normal and low BMD subjects was more frequent than gingivitis. Patients with normal and low bone mineral density (BMD) were similar in regard to the prevalence of periodontitis and gingivitis (Figure 1).

**Table 1. Mean ± SD of clinical variables of periodontal status in different groups.**

| Groups | CAL | P-value | CPD | P-value |
|---|---|---|---|---|
| **Osteoporotic** | 2.79 ± 0.58 | | 1.86 ± 0.58 | |
| **Normal** | 1.97 ± | 0.06 | 1.74 ± 0.56 | 0.89 |
| **Osteoporotic** | 2.79 ± 0.58 | | 1.86 ± 0.58 | |
| **Osteopenic** | 2.32 ± 0.52 | 0.44 | 1.82 ± 0.74 | 0.8 |
| **Osteopenic** | 2.32 ± 0.52 | | 1.82 ± 0.74 | |
| **Normal** | 1.97 ± 0.32 | 0.44 | 1.74 ±0.56 | 0.17 |
| **Low BMD** | 2.56 ± 0.58 | | 1.38 ± 0.46 | |
| **Normal** | 1.97 ± 0.32 | 0.01 | 1.74 ±0.56 | 0.05 |

CAL: Clinical Attachment Level, CPD: Clinical Probing Depth, BMD: Bone Mineral Density.

While clinical attachment loss averaged 1.97 ± 0.32 mm in the control group, the variable equaled 2.56 ± 0.58 mm in subjects with lower BMD (P=0.01). Details of attachment loss for each of the groups are shown in Table 1. Mean clinical probing depths in the control group, osteopenic and osteoporotic patients were 1.74 ± 0.56, 1.82 ± 0.74 and 1.86 ± 0.56mm respectively. During the next stage of analysis, both osteopenic and osteoporotic patients were considered as subjects with low bone mineral density. There were no significant differences between normal and low BMD patients.

Although bleeding on probing was 89.3% in normal subjects and 94.4% in subjects with lower BMD (P=0.23), the bleeding index measurement in various subgroups of the low BMD group showed a slight significant difference. The results of BOP in osteoporotic and osteopenic subjects were 92.3% and 95.9% respectively (P=0.4). Clinically measurable tooth mobility was encountered in 14.6% of the case subjects and 5.3% of control subjects (P=0.05). Statistical comparison of the number of remaining teeth between the two groups did not show any differences (P=0.66).

## *Discussion*

The aim of the present study was to evaluate the association of systemic bone mineral density and periodontal indices of health and disease. Osteoporosis and periodontitis affectboth the systemic bone mineral density and alveolar bone. Controversy regarding the association between these two well known bone damaging diseases began in 1960. A number of researchers attempted to answer the question of whether alveolar bone loss is a local manifestation of osteoporosis or is an independent consequence of local factors which cause periodontal disease.

Al Habashneh et al. showed in a cross-sectional study that there is no significant difference in the severity and extent of alveolar crestal height and clinical attachment among women with normal bone mineral density, osteoporosis, and osteopenia. It was revealed in multivariate analysis that women with osteoporosis were more likely to have severe periodontitis and bone loss.[16] Also, Moedano et al. identified the possible association of periodontitis and osteoporosis using a modified version of the extent and severity index (Table 2).[17]

We could not identify any significant differences with respect to CPD, BOP, the number of remaining teeth, and tooth mobility between normal control subjects and patients with lower BMD was the only clinical variable that was significantly greater in subjects of the case group compared to the control group, indicating an accelerated deterioration of the attachment apparatus.

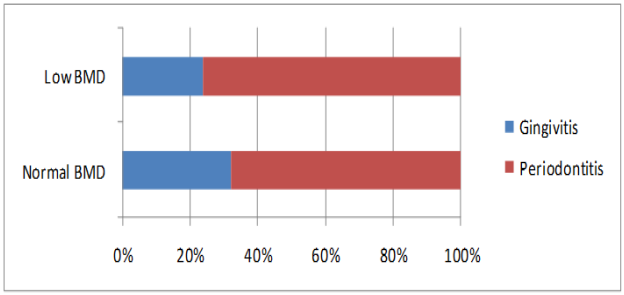


**Figure 1. % prevalence of periodontitis and gingivitis amongst subjects with normal and low bone mineral density (osteopenic and osteoporotic patients). Normal BMD (Periodontitis: 68%, Gingivitis:32%); Low BMD(Periodontitis:76%, Gingivitis :24%)**

Park et al. demonstrated similar genetic polymorphism variations detected in the osteoprotegrin gene (OPG) of osteoporotic patients who were suffering from periodontitis.[26] The other major contributing factor to resorption is reduced secretion of estrogen hormone in women during menopause. Experimental studies have shown proinflammatory cytokines as the primary mediators of accelerated bone loss at menopause, which is associated with osteoclastic bone resorption in specific diseases such as periodontitis.[27]

As stated by Allam et al., certain considerations are required in the treatment of patients suffering from both periodontitis and osteoporosis.[28] They showed that an additive pathological effect of the above diseases resulted in the occurrence of increased bone loss. However, the design and in vitro nature of the study was not adjusted for identification of a causal relationship. In order to assess a causal relationship, an interventional clinical trial study would be more valuable.

Although a limited number of controlled clinical trial studies are available in the topic of prevention of progressive bone loss and periodontitis in osteoporotic patients, there is lack of conclusive data in this regard. Some authors did not identify any additive effects of the use of sub-antimicrobial doses of doxycycline in this field, while others concluded that low doses of doxycycline may have some advantages in reducing progressive attachment loss.[29,30]

Miley et al designed a cohort study of fifty one patients receiving supportive periodontal therapy.[31] Twenty three subjects who received vitamin D and calcium supplementation showed shallower PD, fewer bleeding sites, lower gingival index, and fewer furcation involvements. Therefore, they suggested that using dietary supplementation in patients suffering from periodontitis that is associated/aggregated by osteoporosis may have some benefits.

After a brief review of the available data and evaluation of the results of the present study, we recommend the following:

1) The results of this study should be interpreted with caution, as the numbers of subjects in the compared groups are small. Although a similar cross sectional study with only 30 patients has been published previously, it is apparent that further prospective studies with larger samples are required for comprehensive results.

2) We calculated the systemic bone mineral density and clinical criteria for periodontal disease. In

addition, we tried to reduce the possibility of bias by using documented exclusion criteria. In addition, it was shown in a study that the presence of T. forsythia in subgingival flora of overweight postmenopausal women was associated with increased levels of alveolar bone loss compared to normal weight subjects.[32] Therefore, the weight of the patients may be considered as a variable in future studies.

3) One of the hypotheses for explanation of the association between periodontitis and osteoporosis is systemic inflammation. Increased circulating cytokines and inflammatory mediators are considered as common factors for both of these conditions, although further controlled clinical studies are required to improve our basic biological knowledge in this field.

4) Some authors have used radiographic techniques (i.e. panoramic view) for comparison of systemic and oral bone densities. Although they have reported a number of associations,[33] we did not include any radiographic evaluation due to the following factors:

a) Sufficient documented data regarding the association between mandibular and systemic bone densities are available. A systemic review by Martinez-Maestre et al. represented that studies on maxillary and/or mandibular radiological findings show a positive correlation in the majority of cases (18 positive vs. three negative), whereas the findings on clinical periodontal examination are inconclusive (six positives vs. five negatives).[34] Therefore, we concentrated on clinical indices.

b) Lack of full mouth parallel radiography /OPG views in almost all of the patients.

c) Ethical considerations dictated.

Identifying a reliable and precise radiographic index for comparison of the density of skeletal and alveolar bones would be necessary.

## *Conclusion*

Although it was not possible to demonstrate a causal relationship between bone mineral density and clinical attachment loss in the periodontium, it appears that these two parameters are strongly correlated.

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**Table 2. Conclusive data published regarding the possible association between bone mineral density and periodontal diseases.**

| Author (year) | Study design (Samples) | Variables | Major Findings |
|---|---|---|---|
| **Tezal et al. (2000)[25]** | Cross-sectional<br>70 postmenopausal women<br>aged 51-78 years | BMD<br>CAL,ABL,PD,PL,BOP,Calculus | Association between BMD and interproximal ABL<br>Lesser extent association between BMD and CAL |
| **Inagaki et al. (2001)[24]** | Cross-sectional<br>89 pre- and 101 post-<br>menopausal women | BMD<br>CPITN | Reduced BMD was associated with<br>Increased CPITN>=3, and<br>Increased amount of tooth loss |
| **Mohammad et al. (2003)[23]** | Cross-sectional<br>30 postmenopausal women | BMD<br>Tooth loss,PL,PD,<br>CAL | Normal subjects:6.8 tooth loss<br>Osteopenic group:10.5 tooth loss<br>Osteoporotic group:16.5 tooth loss |
| **Yoshihara et al. (2004)[22]** | Longitudinal<br>3 years follow up<br>179 subjects | BMD<br>CAL | BMD associated with number of progression sites had>= 3mm attachment loss |
| **Shen et al. (2004)[21]** | 43 post menopausal women | BMD<br>PL,PD,CAL,Recession | Osteoporotic patients showed greater PD in proximal sites, increased attachment loss in mandible, less CAL and recession in maxilla |
| **Inagaki et al. (2005)[20]** | Cross sectional<br>350 women: 171 pre- and<br>185 postmenopausal | BMD<br>CPITN, tooth number | CPITN=3 and 4 increased as BMD decreased |
| **Takaishi et al. (2005)[19]** | Cross-sectional<br>40 postmenopausal women<br>aged 50-69 years | BMD<br>ABL,PD,Mobility | Association between systemic/alveolar BMD, periodontal pocket and tooth mobility |
| **Phipps et al. (2007)[18]** | Cohort<br>2.7 years follow up<br>1347 subjects | BMD<br>CAL,PD,Calculus,<br>Plaque,Bleeding | There was not any association between BMD or annualized rate of BMD, the numer ofteeth,and periodontitis progression |
| **Moedano et al. (2009)[17]** | Cross-sectional<br>166 subjects<br>Aged >=60 | BMD<br>Modified extent &<br>Severity index | Association between severity of periodontitis, oral hygiene and osteoporosis medication., and association between extent index and smoking, osteoporosis, and osteoporosis medication. |
| **Al Habashneh et al. (2010)[16]** | Cross-sectional<br>400 postmenopausal women<br>Average aged:62.5 | BMD<br>ALB,CAL,PD,BOP | Osteoporosis was associated with severe bone loss and periodontitis |
| **Present Study** | Cross-sectional | BMD<br>CAL,PD,BOP,<br>Mobility,teeth loss | Osteoporosis only associated with CAL |