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# Correlation Between Decreased Bone Density and Periodontal Diseases

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**Abstract:** Osteoporosis is considered as a risk factor for periodontal diseases. There are limited studies about the correlation between two conditions and controversy exists between different studies. The objective of this study was to assess the correlation between osteoporosis and periodontal diseases.In this study, 150 female patients referred to a bone density measurement center in 2014-15 were consecutively sampled. The sample was consisted of 3 groups each 50 patients as normal bone density, osteopenia and osteoporosis. All patients underwent periodontal examination. The gathered data included age, bone mass densitometry and periodontal examinations including probing depth, gingival recession, clinical attachment loss, gingival index and plaque index. Mean (±SD) age of the sample was 58.33 (±9.02) years (range, 45-75 years). No significant difference was detected regarding periodontal disease between normal subjects, osteopenia and osteoporosis groups. In osteoporosis group, 63% of the sample was older than 65 years of age. There was a significant association between age and osteopenia as well as osteoporosis ($p< 0.0001$). In comparisons made between periodontal examinations and age groups, no significant correlation was found between periodontal diseases indices and age group.There was no significant correlation between decreased bone density and periodontal diseases indices.

**Key words:** Decreased bone density, periodontal disease, osteoporosis, osteopenia, Iran

## INTRODUCTION

Osteoporosis literally means porous bone. In other word, bone becomes more porous and weakens and atrophy occurs. According to the International Osteoporosis Foundation, osteoporosis is a bone disease disorder characterized by decreased bone mass and changes in microscopic structure of bone tissue which leads to increased bone fragility and higher risk of fracture (not necessarily bone fracture occurrence) (Miller *et al*., 1996; Esfahanian *et al*., 2014). These bone changes can be indirectly and non-invasively recognized by Bone Mineral Density (BMD) measurement. This measurement can be done via several ways, the best one is Dual-energy X-ray Absorptiometry (DXA). This method is considered as the gold standard method and can measure peripheral as well as central bone densities. The World Health Organization (WHO) has proposed scientific definition and the following categorization for osteoporosis based on BMD measurement:

Normal bone mass: A value of BMD within one standard deviation of the young adult (T-score greater than or = 1 SD) Osteopenia: A value for BMD more than one but less than 2.5 standard deviations below the young adult (T-score ≤-1 and >-2.5 SD) Osteoporosis: A value for BMD 2.5 or more standard deviations below the young adult (t-score ≤to -2.5).

Osteoporosis is categorized as primary or secondary types. Primary osteoporosis can occur in both genders and in any age, but usually occurs in females after menopause and in men with advancing age. Secondary osteoporosis occurs after taking some medications or in conditions such as hyperthyroidism and celiac disease (Mattson *et al*., 2002). Factors such as age, gender, race, lifestyle, diet and decreased sun exposure are recognized as risk factors for osteoporosis. Also, factors such as hematologic disorders, malnutrition and some medications have been proposed as risk factors for secondary osteoporosis(Megson *et al*., 2010).

Periodontal disease is a condition which occurs as a result of infection and inflammation in the gingiva and bones around the teeth. In early stage which is called gingivitis, the gingiva is swollen and inflamed and bleeding may occur. In advanced stages, it is called periodontitis where recession occurs in the gingiva and even some parts of tooth root may be exposed and the tooth appears longer than normal. Bone tissues around

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the teeth can be damaged via several mechanisms which result in tooth loosening and if not treated, finally tooth loss occurs. Periodontal disease usually affects adults, though some forms may be seen more commonly in children. The prevalence of periodontal disease rises with advancing age. According to a report, about 47% of people older than 30 years and 70% of those older than 65 years in the US have periodontal disease. This disease is more common in males (56%) than in females (38%). Its prevalence is more common among the poor (65%), those with educational level lower than high school (67%) and smokers (64%) (Otogoto and Ota, 2003).

Recently, periodontal disease has been noted as a threat for those with respiratory diseases, high blood glucose and osteoporosis. But despite this epidemiological relationship, the accurate mechanism of these relationships has not been recognized (Pilgram *et al*., 2002). The risk factors for osteoporosis and periodontal disease are very similar and both conditions are related to advanced age and generally their prevalence is reported to be higher after age 35 (Esfahanian *et al*., 2014). These diseases (periodontal disease and osteoporosis) result in bone loss. Osteoporosis is a metabolic disease but periodontal disease is an infective-inflammatory process. But, several common factors can adjust relationship between these two diseases. Both diseases are conditions which are caused by multiple factors (Esfahanian *et al*., 2014). In a previous study by the Rheumatology Research Center of Tehran University of Medical Sciences, it was revealed that bone density of normal Iranian subjects was lower than standard global values (measured by Hologic scanner) which reflects higher susceptibility of Iranian race to osteoporosis (Akbarian *et al*., 2005). It does not pass long time since the relation between osteoporosis and periodontal disease has been noted (Haghighati and Nasri, 2007; Mohammadi *et al*., 2014 ). In 1994, osteoporosis has been proposed as a risk factor for periodontal disease. Limited number studies have been done in this regard which due to several reasons such as having cross-sectional design, not having control group, local and systemic confounding factors, or the inaccurate method of measuring bone mass density have yielded controversial results (Wowern *et al*., 1994). Regarding the controversies in the literature about this topic, the objective of this study was to assess relationship between osteoporosis and periodontal diseases.

## MATERIALS AND METHODS

In this study, 150 females referred to a bone density measurement center in 2014-15 were consecutively sampled. Written informed consent was obtained from all patients. The study protocol was approved in our medical university. The patients were categorized as normal, osteopenia, or osteoporosis (each 50 cases). The study population consisted of post-menopause women with age range of 45 - 75 years. The age groups were categorized as 45 - 55, 55 - 65 and over 65 years. Those with defective DXA reports, smokers, alcoholics, systemic diseases such as diabetes, taking medications affecting periodontal disease such as Central Nervous System (CNS) medicines, surgery, or any factor which affects periodontal disease were excluded. All patients underwent DXA bone mass measurement of the lumbar spine and femur. Then the patients underwent periodontal examination. The gathered data included age, bone mass densitometry and periodontal examinations including probing depth, gingival recession, clinical attachment loss, gingival index and plaque index.

**Probing Pocket Depth (PPD):** This was measured by Williams probe (Hu-Friedy, USA) in 4 locations of the tooth based on mm.

**Gingival Recession (GR):** The distance between Cement Enamel Junction (CEJ) and marging of the gingiva was measured by Williams probe.

**Bleeding on Probing (BOP)**

**Clinical attachment loss:** By measuring probing depth and gingival recession for each tooth and by summing these two values, clinical attachment loss was calculated. Plaque index (Silness and Loe method): the amount of plaque on each probe surface in 4 locations (buccal, mesial, distal and lingual) with grade range of 0-3 for each surface was categorized.

The gathered data were entered into the SPSS software (Ver. 22.0) and were analyzed using the t-test, Kruskal-Wallis and Chi-squared tests. A P value of less than 0.05 was considered statistically significant.

## RESULTS AND DISCUSSION

Mean (±SD) age of the sample was 58.33 (±9.02) years (range, 45-75 years). Mean (±SD) age in normal subjects was 55.20 (±3.99), 58.00 (±7.23) in osteopenia and 66.78 (±6.21) years in osteoporosis group ($p<0.0001$). Table 1 presents periodontal disease indices in the three studied group with no significant difference between the groups.

About 64 and 54% of osteopenia and osteoporosis patients had bleeding on probing. There was no significant difference between the groups regarding

Table 1: Periodontal examination in the three studied groups

| Parameters | Normal subjects | Osteopenia | Osteoporosis | p value |
|---|---|---|---|---|
| Probing depth (mm) | 2.76 (±0.74), 3 | 2.84 (±0.82), 3 | 3.01 (±0.77), 3 | 0.24 |
| Gingival recession (mm) | 1.42 (±0.49), 1 | 1.50 (±0.49), 1.35 | 1.47 (±0.50), 1.15 | 0.49 |
| Clinical attachment loss (mm) | 3.60 (±0.97), 3.75 | 3.72 (±0.99), 3.80 | 3.95 (±0.93), 3.95 | 0.20 |
| Plaque index | 0.40 (±0.19). 0.40 | 0.38 (±0.20), 040 | 0.46 (±0.19), 0.50 | 0.13 |

Table 2: Periodontal disease indices in age groups

| Parameters | 45-55 years | 56-65 years | 66-75 years | p value |
|---|---|---|---|---|
| Probing depth (mm) | 2.75 (±0.74), 3 | 2.88 (±0.75), 3 | 3.04 (±0.85), 3 | 0.22 |
| Gingival recession (mm) | 1.43 (±0.50), 1.05 | 1.60 (±0.46), 2 | 1.37 (±0.49), 1 | 0.10 |
| Clinical attachment loss (mm) | 3.70 (±0.93), 3.80 | 3.56 (±0.92), 3.50 | 4.05 (±1.03), 4.1 | 0.06 |
| Plaque index | 0.39 (±0.20), 0.3 | 0.45 (±0.18), 0.5 | 0.41 (±0.19), 0.4 | 0.25 |

Data are presented as mean (±SD), median

Table 3: Periodontal diseases indices in different age groups in the three studied groups

| Parameters | Variables | 45-55 years | 56-65 years | 66-75 years | p value |
|---|---|---|---|---|---|
| Probing depth (mm) | Normal | 2.80 (0.76) | 2.56 (1.42) | - | 0.49 |
| | Osteopenia | 2.64 (0.75) | 3.02 (0.71) | 2.95 (1.11) | 0.44 |
| | Osteoporosis | 3.00 (0.0001) | 2.89 (0.84) | 3.07 (0.77) | 0.84 |
| Gingival recession (mm) | Normal | 1.42 (0.50) | 1.42 (0.50) | - | 0.85 |
| | Osteopenia | 1.46 (0.51) | 1.72 (0.42) | 1.21 (0.41) | 0.20 |
| | Osteoporosis | 1.50 (0.70) | 1.55 (0.47) | 1.42 (0.51) | 0.70 |
| Clinical attachment loss (mm) | Normal | 3.67 (0.98) | 3.23 (0.86) | - | 0.26 |
| | Osteopenia | 3.75 (0.89) | 3.59 (1.02) | 3.88 (1.23) | 0.75 |
| | Osteoporosis | 3.75 (0.35) | 3.69 (0.86) | 4.10 (0.98) | 0.32 |
| Plaque index | Normal | 0.38 (0.19) | 0.50 (0.10) | - | 0.10 |
| | Osteopenia | 0.39 (0.22) | 0.41 (0.19) | 0.32 (0.15) | 0.50 |
| | Osteoporosis | 0.60 (0.0001) | 0.47 90.19) | 0.44 (0.19) | 0.46 |

Data are presented as mean (SD)

Table 4: Bleeding on probing in different age groups in the studied groups

| Parameters | Variables | 45-55 years | 56-65 years (%) | 66-75 years | p value |
|---|---|---|---|---|---|
| Bleeding on probing | Normal | 16 (84.2%) | 3 (15.8) | - | <0.0001 |
| | Osteopenia | 6 (33.3%) | 6 (33.3) | 6 (33.3%) | |
| | Osteoporosis | 2 (8.7%) | 7 (30.4) | 14 (60.9%) | |
| Not bleeding on probing | Normal | 26 (83.9%) | 5 (16.1) | - | <0.0001 |
| | Osteopenia | 16 (50%) | 12 (37.5) | 4 (12.5%) | |
| | Osteoporosis | - | 10 (37) | 17 (63%) | |

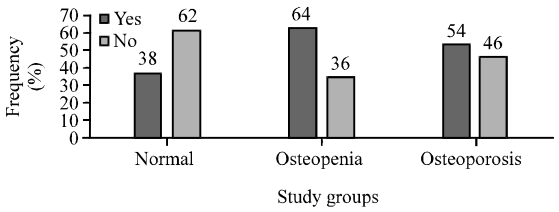


Fig. 1: Bleeding on probing in the three studied groups

bleeding on probing (p = 0.68) (Fig. 1). Figure 2 shows age groups in the three studied groups. In osteoporosis group, 62% were in the age group of older than 65 years. There was a significant relationship between age and osteoporosis as well as osteopenia.

In comparisons made between periodontal examinations and age groups, no significant difference was observed between each of periodontal indices and age groups (Table 2). There was no significant association between bleeding on probing and age (p = 0.41). In age group of 66-75 years, the frequency percentages of bleeding and not bleeding on probing were very similar (Fig. 3).

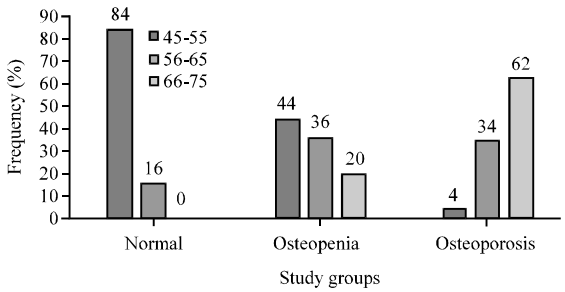


Fig. 2: The frequency distribution of age group in the three studied groups

There was no significant difference between periodontal disease indices and age groups (Table 3). There was a significant correlation between bleeding on probing and age group in the three studied groups (Table 4).

In this study, all periodontal diseases indices increased from normal subjects group when compared to osteopenia group and similarly from osteopenia group to osteoporosis group. In other words, with decreased bone

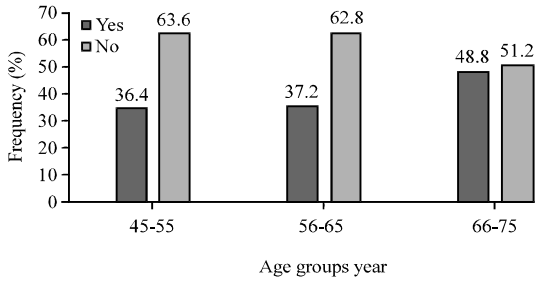


Fig. 3: The frequency percentage of bleeding on probing based on age group

density, the severity of periodontal disease increased, although this difference was not statistically significant. Osteoporosis patients were older than others. The criteria of periodontal disease existence increased with advancing in age, but this was not significant. Since periodontal disease indices were more common in osteoporosis group, it could be stated that age has a role in periodontal disease and osteoporosis.

There is evidence that periodontal disease in women with osteopenia is more common than healthy women. Also, periodontal disease is more common in osteoporosis than in osteopenia. In this study, these differences were not statistically significant, but they cannot be overlooked. Weyant *et al.* (1999) did not find any correlation between osteoporosis and periodontal diseases indices(Weyant *et al.*, 1999). Marques *et al.* (2015), Passos *et al.* (2010) and Devlin (2012) also did not find any relationship between these two conditions. The reports of the mentioned studies are in conformity with what we observed in this study. However, there are studies that confirmed the presence of significant relationship between these two conditions. Esfahanian *et al.* (2014) study clinical attachment loss and gingival recession were significantly more common in osteoporotic patients than in normal healthy subjects (Esfahanian *et al.*, 2014). Sultan and Rao (2011) reported a significant relationship between osteoporosis and clinical attachment loss. They added that decreased bone mineral density and disorders of jaw bones are two related disorders. As an hypothesis, osteoporosis is a risk factor for progression of periodontal disease and vice versa periodontal disease can predispose to osteoporosis development. There are hypothetic models to describe this relationship. It is suggested that decreased bone density from osteoporosis may accelerate alveolar bone loss due to periodontitis and facilitate periodontal bacterial invasion. Invasive bacteria can directly, via release of various toxins and indirectly, via inflammatory mediator secretion, cause changes in normal homeostasis of bone tissue, increased osteoclasts activity and decreased in local and systemic bone density. Wende *et al.* (1996) reported that a direct relationship exists between decreased bone density and periodontal diseases. Also, in patients with decreased bone density, decrease in bone mass is also seen which causes imbalance between bone loss and bone formation and finally results in decreased bone mineralization and osteoporosis. As osteoporosis and periodontal disease are both examples of diseases that are characterized by bone loss, this relationship is explained. Vishwanath *et al.* stated that decreased bone density is associated with periodontal attachment loss and bone loss. They reported that these two conditions both result in bone loss. Osteoporosis is a metabolic disease and periodontal disease is an infective-inflammatory process but several common manifestations can explain the relationship between these two diseases. Both diseases are multi factorial conditions (Wowern *et al.*, 1994). Gumus *et al.* (2013) showed a direct relationship between osteoporosis and bone loss in jaw bone with periodontal disease. Studies have shown that osteoporosis results in tooth loss. This is because with osteoporosis, the density of bones which support the teeth is decreased. Finally, this causes the teeth to not have a strong support. Yoshihara *et al.* (2005) reported that a direct relationship exists between tooth loss, bone loss and attachment loss due to periodontitis with decreased bone density. The reason of controversy between the studies can be due to differences in sample sizes and poor control over effective environmental factors. Also, it can be stated that the likelihood of periodontal disease development is different among people with different diseases. It has been reported that periodontal diseases are more prevalent in those with diabetes or cardiovascular diseases. Maybe the fact that some patients in some studies had diseases that can affect the prevalence of periodontal disease can justify the discrepancies between various studies.

In this study, we observed that older patients were more frequently affected by osteoporosis and periodontal disease indices increased with advancing in age, though this increase was not statistically significant. Osteoporosis can occur in both genders and in any age, but usually occurs in females after menopause and in men with advancing age (Anil *et al.*, 2013). The risk factors for osteoporosis and periodontal disease are common and both conditions are associated with increase in age and both usually start after age 35 (Zapata *et al.*, 2013). Habashneh *et al.* (2010) showed that in women with mean age of 62 years, a significant relationship exists between periodontal disease and decreased bone density.

Takahashi *et al*. (2012) reported that with increase in age, the likelihood of developing periodontal disease and osteoporosis increases. They added that the exact mechanism of this relationship is not known and needs more studies for better clarification. In our study, we did not find any relationship between age and periodontal disease. This could be due to differences in mean ages of the studied patients between various studies and the severity of osteoporosis although, significant difference was observed between age and osteoporosis in this study. Osteoporosis is a multi-factorial disease and factors such as decreased physical activity, poor nutrition, deficient calcium and vitamin D intake, excessive alcohol intake, smoking and other factors can contribute to osteoporosis development. Since, periodontal disease has microbial origin, but its cause may be multi-factorial, therefore the importance of determining this relationship in prevention and treatment of both conditions is obvious. Despite reports addressing the relationship between osteoporosis, age and periodontal disease, the role of osteoporosis in initiation and progression of periodontitis is not clear exactly (Kuo *et al*., 2008). Another reason of the effect of age on osteoporosis and periodontal disease in menopause state in women is menopause. Menopause results in decreased estrogen and consequently severe changes in bones. On the other hand, due to hormonal changes in menopause, women become more susceptible to inflammatory diseases of tissues supporting the teeth. Especially, if oral and dental hygiene is not maintained properly, the likelihood of this condition occurrence increases (Famili *et al*., 2007).

## CONCLUSION

There was no significant correlation between decreased bone density and periodontal disease.

## LIMITATIONS

Limitations in this study were not assessing systemic diseases of the patients and not having a control group. Also, performing cohort studies with considering confounding factors such as taking calcium and vitamin D is recommended.

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