

EVALUATING THE EFFECT OF OSTEOPOROSIS AND PERIODONTITIS IN WOMEN CLOSE TO MENOPAUSE

Ehsanpour MG,¹ Etemadi A²

1. Resident, Department of Periodontics, School of Dentistry, Islamic Azad University, Tehran Branch, Tehran, IRAN.

2. Assistant Professor, Department of Periodontics, School of Dentistry, Islamic Azad University, Tehran Branch, Tehran, IRAN.

ABSTRACT

Aim: Osteoporosis and periodontal are diseases that as the age increases, their prevalence increases, and bone loss is a common feature of these two diseases. The purpose of this study was to evaluate the association between bone mineral density and periodontitis in women close to menopause.

Materials & Method: In this cross-sectional study, among the women referred to the densitometry center in one of the Tehran medical centers who were applicants to measure bone mineral density (BMD) by the diagnosis of a specialist, 345 subjects were enrolled into the study to evaluate the presence of osteoporosis. These people had eligible age. The subjects after performing densitometry underwent periodontal examinations, including Probing Depth (PD), Clinical Attachment Loss (CAL) and Bleeding on Probing (BOP), then data were analyzed using SPSS software, ANOVA and Kruskal-wallis tests.

Results: In the entire study population, the mean PD, BOP, and CAL in osteoporotic patients showed a significant difference from normal and osteopenic subjects, but there was no significant difference between osteopenic and normal subjects. The CAL index after menopause in osteoporotic women was significantly different from that of normal people.

Conclusion: Osteoporotic subjects showed more severe degrees of periodontitis than normal and osteopenic subjects, but osteopenic individuals and subjects with normal BMD had no significant difference in mean CAL, which suggests the importance of early detection of BMD decrease before its effect on periodontal tissues.

Key words: : Periodontitis, Osteoporosis, Bone mineral density.

Introduction

In recent years, attention to the link between osteoporosis and periodontal diseases has increased significantly. Both osteoporosis and periodontitis are essentially multifactorial. They have several similar possible and definite risk factors in their pathophysiology.¹ Osteoporosis is a skeletal disease characterized by a reduction in bone mass and microstructural changes in the bone, which increases the risk of bone fragility and increased bone fractures.² Periodontitis is a disease with a destructive nature characterized by the presence of inflammation within the supporting structures of teeth, and the response of these tissues to localized inflammatory changes leads to bone loss and loss of attachment of these tissues to the teeth.³ In general, it has been admitted that the most important etiologic factor in periodontitis is subgingival plaque with associated bacterial infection and, consequently, loss of soft tissue attachments.⁴ Periodontitis, like osteoporosis, is a silent disease and is asymptomatic as long as it does not progress to advanced stages such as loose teeth, abscess and loss of teeth.⁵

In the past, osteoporosis was considered as a physiological process associated with increased age, but in today's new definition, it is a chronic systemic disease that may occur at any age, and its etiology is associated with endocrine, metabolic and individual factors.⁶ Based on the belief that bone erosion occurs at the same time in mandible and other bones of the body, loss of teeth and non-traumatic fractures may be a common manifestation of a process.^{7,8} Studies have shown that mandibular bone mineral density (BMD) is lower in subjects with periodontitis than in those who are periodontally healthy.⁹

The gold standard for measuring osteoporosis is the measurement of bone mineral density (BMD) using the

Energy X ray absorbitometry (DXA) Dual method. BMD is calculated based on the T-Score standard (World Health Organization Standard, that considered the average density of 20-30 years old people of a same sex as the c criterion). T-Score>-1 is diagnosed as normal, -2.5<T-Score<-1 as osteopenia, and T-Score<-2.5 as osteoporosis.¹⁰

One of the first studies to investigate the relationship between osteoporosis and periodontal disease was conducted in 1960s by Groen *et al.*, which raised the possibility of linking these two diseases to patients who had periodontitis and decreased bone density in the vertebrae and forearm at the same time.¹¹

Many studies have shown that osteoporosis and periodontitis are related.¹²⁻¹⁶ There are data on the association of osteoporosis with the onset and progression of periodontitis in human studies.¹⁷ On the other hand, postmenopausal women with osteoporosis had a higher chance of having periodontitis than women who did not have osteoporosis.¹⁵ In a multi-year study, individuals with osteoporosis showed a higher rate of progression of alveolar bone erosion over a 3-year period than those without osteoporosis, and this erosion was more pronounced especially in those who had periodontitis at the beginning of the study.¹⁸

Although the relationship between periodontitis and bone mineral density has been studied extensively, however, there are many contradictions in the results of these studies that can be due to small sample size, limited control of potential confounding factors, and different definitions of osteoporosis and periodontitis.¹⁷ One of the reasons for the contradictions is the measurement of the severity of periodontitis based on different indexes. Several studies have calculated the severity of periodontitis based on the amount of alveolar bone loss by radiographic

measurements.¹⁹⁻²⁶ Some studies have used the index of clinical attachment loss (CAL) of teeth,^{1,12,27-30} and some other have used the index of measuring the periodontal probing depth (PPD)³¹ to calculate the severity of periodontitis. Although majority of studies that used radiographic indexes showed a positive relationship between osteoporosis and periodontitis,^{14,19,22,24} but there are also studies that have not found any significant relationship with them,^{21,23} on the other hand, studies that used the CAL and PD indexes have shown some positive relationships^{1,12,13,27} and some have not shown any significant relationship.³²⁻³⁵ In recent years, the severity of periodontitis has been clinically evaluated mainly by measuring the loss of periodontal attachment to teeth tissue (CAL).³⁶

In a systematic review study conducted by Marinez-master *et al*, it was shown that most of studies performed on maxillary or mandibular radiographs or both of them showed a positive relationship between osteoporosis and periodontitis, while studies conducted on periodontal clinical examinations had unclear results, the reason for this uncertainty has been cited due to cases of small sample size, limited control of confounding factors, and inaccurate definitions of osteoporosis and periodontitis.⁵ In general, considering that most of the studies are conducted on postmenopausal women, and one of the limitations of these studies was the small sample size, in this study, we have tried to determine the age range of women with osteoporosis before menopause, and the sample size would be to an extend to provide a higher degree of certainty for the results.

Materials & Method

This study was a cross-sectional study with considering the confidence level of 95% and the standard deviation of 25.04 for BOP index in the osteoporotic women group and by considering the difference of 5 units, the minimum sample size was determined as 345 subjects.¹ Based on this, 4533 women close to menopause who referred to one of the medical centers in Tehran province and an expert physician had administrated a densitometry from the waist and pelvic bones for them in order to assess osteoporosis, after obtaining informed consent from patients in the medical history of patients was recorded. The parameters assessed by the questionnaire included age and menopause status. The menopause status was examined through a question about the monthly menstruation, women who had no menstruation for more than 14 months were categorized as postmenopausal women.

The specifications of the research samples included: women close to menopause, over 40 years of age, applicant to do densitometry prescribed by a doctor, having at least 11 teeth in the jaws, and exclusion criteria included: people with complete edentulism, people with parathyroid disease, metabolic bone diseases that affect calcium and phosphorus metabolism, history of osteoporosis treatment, cigarette smoking, alcohol, thyrotoxicosis with poor control, malignancy, long term treatment with corticosteroid (over 7

months), ovarian removal, lactation, history of gum surgery, history of gum surgery (envelope flap removal) over the last 7 months and diabetes.^{1,5,21,27}

Densitometry from the waist and pelvic region was performed on patients by dXa method and using a Hologic QDR4500 device (Hologic Inc., Bedford Explorer MA, USA). Among the two areas measured for each patient, the most severe T-Score was used to determine osteoporosis or osteopenia.¹⁰

Then, subjects with any densitometry score that qualified for inclusion were referred to the dental clinic of Khatam-Ol-Anbia Clinic for periodontal examinations, along with an introduction letter without densitometry report. The examinations using a Williams periodontal probe include BOP (bleeding during probing after 35 seconds from the penetration of the probe into the gingival groove), PD (the penetration rate of the probe in the gingival groove, distance of the gingival margin to the penetration depth of the probe) and CAL (clinical attachment loss of teeth).

CAL calculation is based on the distance in millimeters from Cemento Enamel Junction (CEJ) to the clinical end of periodontal pocket. The CAL was evaluated based on the measurement at 7 points of teeth 46, 40, 31, 36, 37, 26, 12, 16 and 15.³⁷ The corresponding sextant score is calculated when at least two teeth from the existing reference teeth are calculated and they are not also candidates for pulling, and if the reference teeth are not present in the corresponding sextant, the rest of the teeth are calculated and the highest score is calculated as the sextant score. If there are no teeth in sextant, then that sextant is calculated. If there are no teeth in sextant, then that sextant is removed and the highest CAL number obtained from that person from that sextant is removed and the highest number of CAL obtained from that person is assigned to that sextant.²⁷ These subjects were then categorized into groups of premenopausal and postmenopausal. Then, the results of densitometry and periodontal examinations were analyzed by SPSS software version 17. One-way ANOVA test was used for multiple comparison, Tukey test for binary comparison in PD and CAL indexes, Kruskal-Wallis tests for comparing BOP index between the three groups, and Mann-Withney test was used for dual comparisons in BOP indexes by using Bonferroni's correction coefficient.

Results

The study population consisted of 345 women, applicants for densitometry prescribed by an expert physician from the femur bone region and L2-L4 lumbar vertebrae in the age range of 40 to 70 years old with an average age of 59.37 ± 7.14 , that based on the densitometric result they were divided into three groups of normal (170 people), osteopenia (95 people) and osteoporosis (75 people).

The average age of ostmenopause group was 59.37 ± 7.14 and average age of premenopausal group was 47.22 ± 5.72 . The overall mean of the CAL index in total statistical population was 1.95 ± 0.52 , PD was 1.72 ± 0.45 mm, and BOP was 18.81% with median of 22.3%. One-way

ANOVA was used to compare the CAL and PD levels between the three groups [Table 1] and Tukey test was used for binary comparison of the groups.

Variable	Normal (184 people) (Mean ± Standard deviation)	Osteopenia (98 people) (Mean ± Standard deviation)	Osteoporosis (76 people) (Mean ± Standard deviation)	p-Value
CAL (mm)	1.76 ± 0.54	1.76 ± 0.32	2.32 ± 0.41	<0.001*
PD (mm)	1.59 ± 0.21	1.61 ± 0.37	1.57 ± 0.31	0.012*
BOP (%)	16.92 ± 12.15	16.23 ± 15.16	25.42 ± 14.62	<0.001**
	MD = 14.28	MD = 11.11	MD = 25.39	

Table 1: Determination and comparison of periodontal indexes (PD, CAL) and median BOP based on the densitometric results in the total study population.

The difference in total study population in triple comparison of the groups in all three indexes was significant.

In the total study population in comparing the periodontal indexes between normal and osteoporosis groups, the mean CAL and BOP in osteoporotic subjects was higher than normal subjects and this difference was significant (P<0.001), but PD had no significant difference (P<0.40). Also, all three indexes in the group of osteoporotic subjects were higher than osteopenic subjects and this difference was significant (BOP, CAL p<0.001), but there was no significant difference between the normal group and the osteopenia group.

The study population was divided into premenopausal women (194 people) and postmenopausal women (152 people). In premenopausal women, there was no significant difference in the PD and CAL indexes between normal group and the osteopenic and osteoporotic groups, and only the PD index was significant between the normal and osteopenia groups. [Table 2]

Variable	Normal (129 people) (Mean ± Standard deviation)	Osteopenia (45 people) (Mean ± Standard deviation)	Osteoporosis (13 people) (Mean ± Standard deviation)	p-Value
CAL (mm)	1.65 ± 0.26	1.68 ± 0.83	3.01 ± 0.54	0.014*
PD (mm)	1.67 ± 0.97	1.75 ± 0.29	1.94 ± 0.47	0.005*
BOP (%)	16.95 ± 14.29	12.45 ± 27.39	16.34 ± 19.04	0.24*
	MD = 20.00	MD = 10.00	MD = 11.11	

Table 2: Determination and comparison of the mean and standard deviation of periodontal indexes (PD, CAL) and median BOP in premenopausal women based on the densitometric results.

In the premenopausal women group, the difference in CAL and PD indexes in triple comparison of the groups was significant. In the postmenopausal women group, there was significant differences in CAL index between the normal and osteoporosis groups, and between the osteoporosis and osteopenia groups. [Table 3]

In the postmenopausal women group, there was significant differences in CAL and BOP indexes in triple comparison of the groups.

Variable	Normal (49 people) (Mean ± Standard deviation)	Osteopenia (48 people) (Mean ± Standard deviation)	Osteoporosis (49 people) (Mean ± Standard deviation)	p-Value
CAL (mm)	2.14 ± 0.84	2.07 ± 0.38	2.14 ± 0.95	0.002*
PD (mm)	2.14 ± 0.42	2.16 ± 0.12	1.94 ± 0.29	0.5*
BOP (%)	15.32 ± 12.84	18.27 ± 84.91	29.92 ± 39.15	<0.001*
	MD = 11.11	MD = 11.80	MD = 30.00	

Table 3: Determination and comparison of mean and standard deviation of periodontal indexes (PD, CAL) and median in postmenopausal women based on the densitometric results.

Discussion

Reviewing the articles showed that factors such as small sample size,^{7,38,40} limited control of confounding factors and inaccurate definitions of osteoporosis and periodontitis,⁵ and studies being cross-sectional and being limited to postmenopausal women³⁸ are the reason for the lack of definitive result in terms of the relationship between osteoporosis and periodontitis.

In a review study conducted by Guiglia *et al* (2012) on the relationship between periodontitis and osteoporosis, it was suggested that although the epidemiological report supports the potential relationship between periodontitis and osteoporosis, the comprehensive analysis of reported data contradicts the results, in which the wide range of definitions of periodontitis and osteoporosis evaluation, study limitations, low control of the study, low numbers of samples, and being limited to postmenopausal women are the reasons for this.³⁸ While in cross-sectional studies on postmenopausal women and older men, there was a significant correlation between BMD and periodontal diseases, while other studies conducted on premenopausal women and younger men, do not support such a relationship.⁹

In this study, the sample size is greater than the majority of studies in this field (333 people). On the other hand, this study also examined the premenopausal women. One of the fundamental differences seen in various studies is the use of different indexes to determine the severity of periodontitis. A number of previous studies have used alveolar bone resorption to evaluate the severity of periodontitis^{15,18,21,22,24} and some other have used clinical indexes such as CAL and PD for this purpose,^{1,12,14,25,28} and based on the decision of the World Congress on Periodontology, the severity of periodontitis is clinically evaluated mainly by measuring the loss of periodontal attachment to tooth structure (CAL).³⁶ In this study, clinical indexes were used. L2-L4 spine and femur bones were used for osteoporosis diagnosis and assessment of bone density,¹⁰ which are used in most studies in this area.

Among the confounding factors, diabetes mellitus is one of the diseases that its effect on periodontal health has been proven and has not been excluded in a number of studies,^{1,21,26} also cigarette smoking has a similar and

positive effect on the periodontal condition, which has been eliminated as a confounding factor in this study.

The present study has evaluated the status of osteoporosis and periodontitis in 345 women close to menopause and over 40 years of age and applicants for densitometry. Based on the densitometric results, the groups were divided to normal, osteoporosis and osteopenia subjects. In this study, BOP, PD and CAL were higher in osteoporotic women than in osteopenic women with normal BMD. The results of this study are consistent with the results of the study by Mohammad *et al.*, who examined the relation of the lumbar spine BMD with CAL^{16,28,40} and the sample size was 28, 54 and 45 people, respectively. This study was also consistent with the study by Von Wonwern *et al.* (sample size of 52 people), in which they showed that clinical attachment loss is significantly higher in osteoporotic subjects.¹²

However, in these studies, the sample size was small. Mohammad showed that subjects with lower lumbar density showed higher values of CAL indexes than those with higher density.^{16,28} In the Brennan study, a significant relationship was also found between CAL and systemic mineral density in a sample size of 1412 people, which this relationship was significant in the absence of subgingival plaque, but among women with subgingival plaque, this subgingival was significant, but this relationship was not significant among women with subgingival plaque, but all individuals were postmenopausal women.²⁹ In another study, he used radiographic index of alveolar crest height (ACH) to evaluate the severity of periodontitis, and it was observed that in subjects under the age of 70 years, there is a significant relationship between forearm bone density and radiographic alveolar crest height, but in the group above 70 years of age, although bone loss was higher, there was no significant relationship.⁴⁰ In the study by Hattatoglu *et al.* on premenopausal women, there was no relationship between skeletal BMD in subjects with healthy periodontal status and people with severe generalized periodontitis. In the present study, the CAL and PD indexes had a significant difference with each other in premenopausal women.⁴⁰ The results of this study are consistent with the results of the study by Pepelassi *et al* on 120 women aged 40-75 years with periodontitis. The relationship between the mineral density of the vertebrae and pelvic bone in this study was investigated with the clinical parameters of periodontitis. They concluded that the mean CAL in subjects with osteoporosis was significantly higher than those with normal BMD, suggesting more severity of periodontitis in these subjects, but there was no significant difference in CAL index between osteopenic subjects and subjects with normal BMS,¹ which the present study confirms these results.

Also, in a study by Takahashi *et al*, on 347 postmenopausal women aged between 55 and 74, there was a significant relationship between mean CAL and BMD reduction on lumbar spine bones,²⁷ which the results of this study are in line with the results of the present study in postmenopausal women.

In the study of Tezal *et al* conducted on 70 postmenopausal women, it was observed that the mean CAL was related to BMD, but did not reach a significant level.¹⁴ In the present study, this difference was significant in postmenopausal women.

The number of studies that have examined the possible relevance of osteopenia with periodontitis is very limited.^{15,29,32} In the study by Weyant *et al.* conducted on a group of 292 elderly women, there was no significant relationship between clinical parameters of periodontitis including CAL, BOP and PD with systemic BMD in osteopenic subjects.³² In the present study, people with osteopenia in the whole population were compared in the form of an independent group with normal group, and in the present study, there was also no significant difference in periodontal indexes between the two groups.

Conclusion

Providing a link between osteoporosis and periodontitis is complicated, because both diseases are multifactorial and both have similar mechanisms, therefore, there is a reasonable biological relationship that says at least part of the periodontal degeneration is affected by systemic bone loss. In most studies, periodontitis has been shown to be a preliminary warning for osteoporosis.⁵ Therefore, periodontitis can act as a screening tool for osteoporosis, but in practice this is a controversial topic, probably due to the various criteria used to define osteoporosis and periodontitis. Finally, considering the total available data, it can be concluded that there is a relationship between osteoporosis and periodontitis, but in order to give a definitive opinion, prospective studies are needed.

In fact, the prevention of osteoporosis is the most sensible approach to overcome the disease, and early diagnosis is one of the foundations of modern medicine.⁷ It seems that the dentist not only plays an important role in the diagnosis and treatment of oral diseases and periodontitis and their relation with systemic health, but can play a significant role as a member involved in the identification and referral of patients to relevant physician and specialists.

Reference

1. Pepelassi E, Nicopoulou-karayianni K, Archontopoulou AD, Mitsea A, Kavadella A, Tsikiakis K *et al.* The relationship between osteoporosis and periodontitis in women aged 45-70 years. *Oral Dis* 2012;18(4):353-59.
2. Slots J. Update on general health risk of periodontal diseases. *Int Dent J* 2003;53(Suppl 3): 200-7.
3. Schwartz Z, Goultschin J, Dean DD, Boyan BD. Mechanisms of alveolar bone destruction in periodontitis. *Periodontol* 2000 1997;14:158-72.
4. American Academy of periodontology. Glossary of periodontal term. 4th ed. Chicago: American Academy of Periodontol 2001.p. 39-40.
5. Martinz-Maestre MA, Gonzalez- Cejudo C, Machuca G, Torrejon R, Castelo-Branco C. Periodontitis and

- osteoporosis: a systematic review. *Climacteric* 2010;13(6):523-29.
6. Kaduganti RR, Gorthi C, Reddy PV, Sandeep N. Osteoporosis: a risk factor for periodontitis. *J Indian Soc Periodontol* 2009;13(2):90-96.
 7. Taguchi A, Tanimoto K, Suei Y, Wada T. Tooth loss and mandibular osteopenia. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1995;79(1):127-32.
 8. Bollen AM, Taguchi A, Hujoel PP, Hollender LG. Case-control study on self-reported osteoporotic fractures and mandibular cortical bone. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000;90(4):518-24.
 9. Ozturk Tonguc M, Buyukkaplan US, Fentoglu O, Gumus BA, Cerci SS, Kirzioglu FY. Comparison of bone mineral density in the Jaws of patients with and without chronic periodontitis. *Dentomaxillofac Radiol* 2012;41(6):509-14.
 10. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. *World Health Organ, Techn Rep Ser* 1994;843:1-129.
 11. Groen JJ, Duyvensz F, Halsted JA. Diffuse alveolar atrophy of the Jaw (non inflammatory from of Parodontal disease) and pre-senile osteoporosis. *Gerontol Clin (Basel)* 1960;2:68-86.
 12. von Wowern N, Klausen B, Kollerup G. Osteoporosis: a risk factor in periodontal disease. *J periodontol* 1994;65(12):1134-38.
 13. Ronderos M, Jacobs DR, Himes JH, Pihlstrom BL. Association of periodontal disease with femoral bone mineral density and estrogen replacement therapy: Cross sectional evaluation of US adults for NHANES III. *J Clin Periodontol* 2000;27(10):778-86.
 14. Tezal M, Wactawski – Wende J, Grossi SG, Ho AW, Dunford R, Genco RJ. The relationship between bone mineral density and periodontitis in postmenopausal women. *J Periodontol* 2000;71(9):1492-98.
 15. Gomes-Filho IS, Passos Jde S, Cruz SS, Vianna MI, Cerqueira Ede M, Oliveira DC, *et al*. The association between postmenopausal osteoporosis and periodontal disease. *J Periodontol* 2007;78(9):1731-40.
 16. Mohammad AR, Brunsvold M, Bauer R. The strength of association between systemic post-menopausal osteoporosis and periodontal disease. *Int J Prosthodont* 1996;9(5):479-83.
 17. Wactawski–Wende J. Periodontal diseases and osteoporosis: association and mechanisms. *Ann Periodontol* 2001;6(1):197-208.
 18. Geurs NG, Lewis CE, Jeffcoat MK. Osteoporosis and periodontal disease progression. *Periodontol* 2000 2003;32:105-10.
 19. Wactawski- Wende J, Grossi SG, Trevisan M, Genco RJ, Tezal M, Dunford RG, *et al*. The role of osteopenia in oral bone loss and periodontal disease. *J Periodontol* 1996;67(10 Suppl):1076-84.
 20. Renvert S, Berglund J, Persson RE, Persson GR. Osteoporosis and periodontitis in older subject participating in the Swedish national survey on aging and care(SNAC- Blekinge). *Acta Odontol Scand* 2011;69(4):201-7.
 21. Sultan N, Rao J. Association between Periodontal disease and bone mineral density in Post menopausal women: A cross sectional study. *Med Oral Patol Oral Cir Bucal* 2011;16(3):e440-47.
 22. Wactawski-Wende J, Hausmann E, Hovey K, Trevisan M, Grossi SJ, Genco RJ. The association between osteoporosis and alveolar crestal height in postmenopausal women. *J Periodontol* 2005;76(11 Suppl):2116-24.
 23. Elders PJ, Habets LL, Netelenbos JC, van der Linden LW, van der Stelt PF. The relation between periodontitis and systemic bone mass in women between 46 and 55 years of age. *J Clin Periodontol* 1992;19(7):492-6.
 24. Payne JB, Reinhardt RA, Nummikoski PV, Patil KD. Longitudinal alveolar bone loss in postmenopausal osteoporotic/osteopenic women. *Osteoporos Int* 1999;10(1):34-40.
 25. Hildebolt CF, Pilgram TK, Yokoyama-Crothers N, Vannier MW, Dotson M, Muckerman J, *et al*. Alveolar bone height and postcranial bone mineral density: negative effects of cigarette smoking and parity. *J Periodontol* 2000;71(5):683-9.
 26. Pilgram TK, Hildebolt CF, Yokoyama-Crothers N, Dotson M, Cohen SC, Hauser JF, *et al*. Relationships between radiographic alveolar bone height and probing attachment level: data from healthy postmenopausal women. *J Clin Periodontol*. 2000;27(5):341-6.
 27. Takahashi O, Yoshihava A, Nakamura K, Miyazaki H. Association between periodontitis and systemic bone mineral density in Japanese community-dwelling postmenopausal women. *J Dent* 2012;40(4):304-11.
 28. Mohammad AR, Bauer RL, Yeh CK. Spinal bone density and tooth loss in a cohort of postmenopausal women. *Int J Prosthodont* 1997;10(4):381-85.
 29. Brennan RM, Genco RJ, Hovey KM, Trevisan M, Wactawski-Wende J. Clinical attachment loss, systemic bone density, and subgingival calculus in postmenopausal women. *J Periodontol* 2007;78(11):2104-11.
 30. Yoshihara A, Seida Y, Hanada N, Miyazaki H. A longitudinal study of the relationship between periodontal disease and bone mineral density in community-dwelling older adults. *J Clin Periodontol* 2004;31(8):680-4.
 31. Kribbs PJ, Smith DE, Chesnut CH 3rd. Oral findings in osteoporosis. Part I: Measurement of mandibular bone density. *J Prosthet Dent* 1983;50(4):576-9.
 32. Weyant RJ, Pearlstein ME, Churak AP, Forrest K, Famili P, Cauley JA. The association between osteopenia and periodontal attachment loss in older women. *J Periodontol* 1999;70(9):982-91.
 33. Pilgram TK, Hildebolt CF, Dotson M, Cohen SC, Hauser JF, Kardaris E, *et al*. Relationships between clinical attachment level and spine and hip bone

- mineral density: data from healthy postmenopausal women. *J Periodontol* 2002;73(3):298-301.
34. von Wowern N, Klausen B, Olgaard K. Steroid-induced mandibular bone loss in relation to marginal periodontal changes. *J Clin Periodontol* 1992;19(3):182-6.
 35. von Wowern N, Klausen B, Hylander E. Bone loss and oral state in patients on home parenteral nutrition. *JPEN J Parenter Enteral Nutr* 1996;20(2):105-9.
 36. Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999;4(1):1-6.
 37. Kidd EAM, Joyston-Bechal S. World health organization oral health surveys- basic methods. 4th ed. Geneva: world health organization; 1997.p. 38-39.
 38. Guiglia R, Di-fede O, Io Russo I, Sprini D, Rini GB, Campisi G. Osteoporosis, jawbones and periodontal disease. *Med Oral Patol Oral Cir Bucal* 2013;18(1):e93-99.
 39. Esfahanian V, Sadighi Shamimi M. Relationship between osteoporosis and periodontal disease review of literature. *J Dent (Tehran)* 2012;9(4):256-64.
 40. Mohammad AR, Hooper DA, Vermilyea SG, Mariotti A, Preshaw PM. An investigation of the relationship between systemic bone density and clinical periodontal status in post-menopausal Asian-American women. *Int Dent J* 2003;53(3):121-5.

Corresponding Author

Dr. Morteza Ghaderi Ehsanpour

Resident,

Department of Periodontics,

School of Dentistry

Islamic University of Medical Sciences, Tehran Branch, Tehran, IRAN.

Email Id: - qaderi.dds@gmail.com