INFLUENCE OF OSTEOPOROSIS AT THE LEVEL OF THE ALVEOLAR BONE IN THE FRONTAL MANDIBULAR REGION

Lumturije Asllani
Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia
lumturieasllani74@gmail.com
Ana Minovska
Eternadent, Skopje, North Macedonia, aminovska@yahoo.com
Mihajlo Petrovski
Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia
mihajlo.petrovski@ugd.edu.mk
Merita Barani
Faculty of dentistry of UBT, Prishtine, Kosova, merita.barani@ubt-uni.net
Kaltrina Aliu
University of Prishtina "Hasan Prishtina", Prishtine, Kosova, x.kaltrina@hotmail.com
Elsa Hashani
Faculty of dentistry- UBT, Prishtine, Kosova, hashanielsa3@gmail.com

Abstract: Osteoporosis as systematic disease has an impact on all skeletal structures, including those in the cranial and cervical regions. Patients suffering from this condition frequently experience tooth loss. Consequently, radiographic evaluation of the jawbones serves as a valuable diagnostic instrument for early detection and ongoing monitoring. For example, panoramic radiography can be utilized for screening of individuals with diminished bone mineral density. There is substantial evidence indicating that the characteristics of decreased skeletal bone mineral density can be effectively identified through dental radiographs. Bone loss associated with osteoporosis occurs throughout the body, and documenting these changes in the jawbones is advantageous, as radiographs are often performed for other dental purposes. This allows for opportunistic diagnosis prior to the occurrence of fractures, even in patients deemed to be at low risk. While dental radiography is not the exclusive diagnostic approach for osteoporosis, it serves as a complementary tool to screening methods that dentists can used for patients who may be unaware of their risk. The main objective of this research was to evaluate the presence of radiographic manifestations of periodontal disease between the osteopenic, osteoporotic group, treated osteoporotic group and non-osteoporotic group. The research encompassed four distinct groups of participants: (1) individuals without osteoporosis, (2) with osteopenia, (3) newly diagnosed and untreated osteoporotic individuals and (4) osteoporotic individuals receiving treatment. Participants were between the ages of 40 and 80 and must have undergone dual energy X-ray absorptiometry (DXA) of the proximal femur and lumbar spine within the last three months. Utilizing magnification and illumination, the distance from the cementoenamel junction to the crestal bone height at both mesial and distal interproximal sites of each tooth was measured. Digital radiographs were used to assess alveolar bone loss in the interproximal areas of the mandibular frontal region. The average measured distance between the cementoenamel junction and the limbus alveolaris in the control group was 4,248 ± 1,672 mm, in subjects with osteopenia it was 3,9841 ± 1,758 mm, in subjects with untreated osteoporosis it was 4,295 ± 1,224 mm, and finally in subjects with treated osteoporosis it was 4,766 ± 0,516 mm. Based on the processed data, we were able to observe that in people with osteoporosis who are amenable to treatment and who are untreated or the treatment has not been started, there is a significant bone reduction compared to healthy people with periodontal disease and in people with osteopenia. The most significant impact of these two conditions is on the distance from the enamel-cement junction to the limbus alveolaris. Hence, the enormous importance of timely treatment of these two diseases in order to prevent significant loss of alveolar bone is also needed.
Keywords: osteoporosis, osteopenia, DEXA, chronic periodontitis.

1. INTRODUCTION

Lopez-Lopez et al. (2011) suggest that the integration of mandibular x-ray indices with assessments of fracture risk may serve as valuable indicators for the early diagnosis of osteoporosis. In particular, visual and morphometric indices have significant relevance in orthopantomograms. Furthermore, the utilization of radiomorphometric indices derived from orthopantomograms can effectively predict the presence of osteoporosis.

Advancing age is associated with a noticeable decline in oral and periodontal health in both sexes, with a marked impact on the middle-aged population. This phenomenon is largely due to diminished estrogen levels in women,

which is a key factor leading to the increased prevalence of these health issues among female individuals. (Dave et al, 2023)

According to the findings of Savic-Pavičin et al.,(2014) the assessment of mandibular bone density and related radiographic indices is a valuable tool for detecting patients with lower bone mineral density (BMD). Other authors also pointed out that orthopantomograms can facilitate early diagnosis of conditions such as osteoporosis or osteopenia, highlighting the significant advantages of this diagnostic method, particularly as it is commonly utilized in everyday dental practice.(Varacallo, et al, 2023)

It is important to note that osteoporotic resorption tends to be more pronounced in bones with a higher ratio of trabecular bone, including the vertebrae, pelvis, and calcaneus. Nevertheless, bones with significant cortical bone, such as the mandible, also undergo resorption. Dental manifestations that may reflect low bone density include the presence of tooth loss, gingival recession, and inadequate fitting of dentures. (Kumar et al,2021)

Orthopantomography (OPG) is frequently used in regular dental assessments. It can be used as a screening instrument for osteoporosis, representing a less expensive alternative to DEXA technology.(Vlasiadis et al, 2007)

According to the findings of Taguchi et al.,(2008) radiomorphometric indices are reliable indicators of osteoporosis. Moreover, it has been reported that certain parameters, including the depth of the mandible's incisure, are also significantly reduced in individuals with osteoporosis.(Rehman et al, 2017)

In distinction from the radio morphometric indices, several oral manifestations have been associated with osteoporosis. These changes include tooth loss, temporomandibular dysfunction, gingival bleeding, dentures that do not fit properly, and an increase in probing depth.(Navabi et al, 2018)

As reported by Dhanya et al,(2023) there is a significant statistical decline in the antegonial index and mandibular cortical width in postmenopausal women compared to their normal counterparts. These variations imply that early pre-clinical manifestations of osteoporosis can be detected in high-risk individuals through the application of OPG.

Osteoporosis is influencing on all skeletal structures, including those in the cranial and cervical regions. Patients suffering from this condition frequently experience tooth loss. Consequently, radiographic evaluation of the jawbones serves as a valuable diagnostic instrument for early detection and ongoing monitoring. For example, panoramic radiography can be utilized for screening individuals with diminished bone mineral density. There is substantial evidence indicating that the characteristics of decreased skeletal bone mineral density can be effectively identified through dental radiographs. Bone loss associated with osteoporosis occurs throughout the body, and documenting these changes in the jawbones is advantageous, as radiographs are often performed for other dental purposes. This allows for opportunistic diagnosis prior to the occurrence of fractures, even in patients deemed to be at low risk. While dental radiography is not the exclusive diagnostic approach for osteoporosis, it serves as a complementary tool for screening that dentists can be used for patients who may be unaware of their risk. Given that dental X-rays provide a two-dimensional representation, thorough visual examination is essential to evaluate bone dimensions and perform necessary calculations for bone mineral density, thereby assessing the risk of osteoporosis. As dental appointments are more frequent, there exists an opportunity for dentists with specialized training to play a more active role in monitoring the overall health of their patients.(Sharma et al,2020)

At the advanced stage of periodontal disease, irreversible resorption and the loss of alveolar bone occur, leading to a reduction in tooth support, which ultimately results in tooth mobility and loss. The contemporary understanding of this condition posits that periodontal disease is the outcome of multifactorial interactions involving the bacterial subgingival biofilm, the immune response of the host, and a range of environmental and risk factors. These include genetic influences, the aging process, nutritional inadequacies, hormonal fluctuations, and the use of tobacco.(Genco et al,1996)

A pivotal question that still requires resolution is whether "presenile osteoporosis of the jaw" might be an early manifestation of osteoporosis. Presently, the potential inverse relationship between periodontal disease and systemic bone remodeling is not well understood. A comprehensive prospective cohort study by Persson et al.(2011) highlighted that osteoporotic patients with periodontal disease are at an increased risk for fractures in the hip or hand. Moreover, recent research by Anbinder et al.(2016) found that experimentally induced periodontal disease aggravated bone loss resulting from systemic ovariectomy. While indirect evidence continues to accumulate in the scientific literature, there is an urgent need for prospective and interventional clinical studies to elucidate this relationship, thereby establishing a robust evidence base for future clinical management.

The condition of osteoporosis in postmenopausal women is characterized by the most significant bone loss occurring within the first five years following menopause.(Ahlborg et al, 2001)] Both osteoporosis and chronic periodontal disease are diseases that progress slowly and share many common traits. The prevalence of osteoporosis in postmenopausal women is well-documented, reaching up to 50%.(Kanis et al, 2008) Additionally, postmenopausal status is linked to an increased severity of periodontitis,(Yu & Wang , 2022) with prevalence rates as high as 30%.(Albandar & Rams, 2002) Osteoporosis is often described as a silent killer, that can lead to fractures that

significantly contribute to morbidity and mortality in the elderly population.(WHO, 2004) Likewise, chronic periodontal disease is associated with higher mortality rates in older individuals, as it may indicate the presence of various chronic health issues.(Linden et al, 2012)

Periodontal disease is characterized as a chronic inflammatory condition affecting the supporting structures of the teeth, assessed through clinical attachment loss, the presence of periodontal pockets, and the loss of alveolar bone. We focused on studies that reported either clinical attachment loss or both clinical attachment loss and periodontal pocket depth. Clinical attachment loss serves as a more reliable indicator of chronic periodontal disease than other measures, such as the count of missing teeth, the depth of periodontal pockets, and the height of the alveolar ridge. Although periodontal pocket depth is frequently utilized for the detection of periodontal disease, alveolar ridge height is evaluated through oral radiographs, which can be influenced by the quality and angle of the X-ray. In contrast, clinical attachment loss is assessed clinically and tends to manifest earlier than radiographic changes. Additionally, generalized bone loss associated with osteoporosis may have a direct impact on the alveolar bone.(Sczepanik et al, 2020)

A significant correlation between clinical attachment loss and osteoporosis has been established, yet further prospective community-based research is necessary to confirm this relationship. There is a need for additional information regarding whether clinical attachment loss and other clinical and laboratory indicators of chronic periodontal disease improve with enhanced bone density resulting from appropriate medical interventions. (Porter & Varacallo, 2023) Demonstrating this may pose challenges, as substantial improvements in bone density typically require several years of follow-up.

The main objective of this research was to evaluate the presence of radiographic manifestations of periodontal disease between the osteopenic, osteoporotic group, treated osteoporotic group and non-osteoporotic group. By fulfilling the aim of the research, we want to find out whether the use of panoramic radiography plays an important role in identifying the initial signs of osteoporosis and conversely whether and how untreated osteoporosis affects periodontal health, by assessing the condition of the alveolar bone.

2. MATERIALS AND METHODS

The research encompassed four distinct groups of participants:

- Individuals without osteoporosis (Total: 10)
- Individuals with osteopenia (Total: 10)
- Newly diagnosed and untreated osteoporotic individuals (Total: 10)
- Osteoporotic individuals receiving treatment (Total: 10)

Participants were required to be between the ages of 40 and 80 and must have undergone dual energy X-ray absorptiometry (DXA) of the proximal femur and lumbar spine within the last three months. Informed consent was secured from all participants.

Data collection took place from July to November 2023. The study was conducted by a single investigator to minimize inter-investigator variability and errors in the classification of periodontal disease.

The medical history included inquiries about tobacco use, alcohol consumption, and hormone replacement therapy.

An operator, utilizing magnification and illumination, measured the distance from the cementoenamel junction to the crestal bone height at both mesial and distal interproximal sites of each tooth examined. Digital radiographs were used to assess alveolar bone loss in the interproximal areas of the mandibular frontal region.

To ensure consistent patient positioning, a bite block was used. Alveolar bone loss was quantified from the cementoenamel junction to the most apical level of the marginal bone. Teeth that were impacted or had dental implants in the examined sites, as well as patients who were edentulous, were excluded from the investigation.

It is important to note that linear measurements from panoramic radiographs have inherent limitations due to unequal magnification and geometric distortion caused by varying exposure parameters across different panoramic machines. Consequently, standardized studies utilizing panoramic radiographs would yield more reliable results in detecting osteoporosis.

3. RESULTS

Based on the processed data, it can be noted that the average age of the subjects from the control group (healthy) individuals is 54,201 ± 10,861 years. In this group, female subjects predominate with 80%, while the remaining 20% of the subjects were male. The average BMI (body mass index) in the control group was 27,827 ± 3,504 kg/m2.

In patients diagnosed with osteopenia, the average age was 53,313 ± 7,211 years. In this group, 80% of the subjects were female, and the remaining are male. The average BMI (body mass index) in the examined group with confirmed osteopenia was 27,932 ± 5,211 kg/m2.

Based on the processed data relating to patients with osteoporosis who have been diagnosed and who have not yet received therapy, it can be noted that the average age was 54,946 ± 9,182 years. In this study group, 90% of the patients were female, while the remaining 10% are male. The average BMI (body mass index) in this study group was 24,135 ± 4,266 kg/m2.

In the patients who make up the study group - patients with osteoporosis who have been treated, the average age was 59,214 ± 9,886 years. Female respondents with 90% dominate this group. The average value for BMI (body mass index) in this study group was 28,158 ± 5,101 kg/m2.

The average measured distance between the cemento-enamel junction and the limbus alveolaris in the control group was 4,248 ± 1,672 mm, in subjects with osteopenia it was 3,9841 ± 1,758 mm, in subjects with untreated osteoporosis it was 4,295 ± 1,224 mm, and finally in subjects with treated osteoporosis it was 4,766 ± 0,516 mm. (Tab. No. 1.)

Tab. No. 1. . Values for the distance from the cementoenamel junction to the limbus alveolaris in the examined specimen

	Control group	**Osteopenia**	**Non-treated osteoporosis**	**Treated osteoporosis**
cementoenamel junction to the limbus alveolaris	4.248 ± 1.672 mm	3.9841 ± 1.758 mm	4.295 ± 1.224 mm	4.766 ± 0.516 mm

Source: authors' research

Based on the processed data, it can be noted that there is no statistically significant difference in terms of the average measured values for the distance from the enamel-cement junction to the limbus alveolaris between the control group and the groups with osteopenia, with osteoporosis without treatment and among the subjects with osteoporosis that has been treated.

Tab. No. 2. Ratio between the distance from the cementoenamel junction to the limbus alveolaris in the control group and the osteopenia group

Difference	-0.264
Standard error	0.767
95% CI	-1.8758 to 1.348
t-statistic	-0.344
DF	18
Significance level	P = 0.7349

Source: authors' research

Tab. No. 3. Ratio between the distance from the cementoenamel junction to the limbus alveolaris in the control group and the untreated osteoporosis group

Difference	0.047
Standard error	0.655
95% CI	-1.3297 to 1.423
t-statistic	0.072
DF	18
Significance level	P = 0.9436

Source: authors' research

Tab. No.4 Ratio between the distance from the cementoenamel junction to the limbus alveolaris in the control group and the group with treated osteoporosis

Difference	0.518
Standard error	0.553

95% CI	-0.6445 to 1.680
t-statistic	0.936
DF	18
Significance level	P = 0.3616

Source: authors' research

4. DISCUSSIONS

Osteoporosis has been suggested as a risk factor for periodontal disease by numerous authors in the contemporary literature, but further studies are needed to establish this causal relationship. This was the main reason why we focused on this study.

Based on data from the Third National Health and Nutrition Examination Survey (NHANES III) of adults over 50 years of age, it is estimated that 13-18% of women (3-6% of men) have osteoporosis, in addition to 37-50% of women and 28-47% of men who have osteopenia.(Loocker et al, 1997) Some literature data have indicated that these subjects are at higher risk for alveolar bone loss. Although both diseases are more prevalent in the elderly population,(Gross et al, 1995) the association is more significant in women,(Lin et al, 2015) and therefore, most studies have focused on older postmenopausal women.

According to a study by Effrianto et al.,(2017) the average reduction in the height of the alveolar ridge in the osteoporosis group was 3.50±1.085 mm. The value of this height in the treated group was 3.15±0.864 mm, and in the untreated group it was 3.90±1.156 mm. These data are in correlation with the results obtained in our study.

Radiographically, osteoporosis is characterized by generalized partial to complete loss of the endosteal lamina in the alveolus/lamina dura and reduced density of the surrounding bone, loss of trabeculae, and increased radiological brightness of the intertrabecular spaces. Such changes can be easily and quickly observed on an orthopantomogram.

Prevention of osteoporosis is the most reasonable way to defeat the disease, and early diagnosis is one of the foundations of modern medicine.(Richa et al, 2017) Therefore, it is recommended that routine oral and bone density screening be mandatory for postmenopausal women to detect early bone changes and disease states, early prevention of the disease, and prevention of disease progression.(Wang & McCauley, 2016) Early detection of these conditions may allow patients to be more fully treated before osteoporosis causes fragility fractures.

This group also includes orthopantomography, which is a significantly simpler and cheaper method for detecting the effects of osteoporosis on the alveolar bone.

5. CONCLUSIONS

Based on the processed data, we were able to observe that in people with osteoporosis who are amenable to treatment and who are untreated or the treatment has not been started, there is a reduction in bone destruction compared to healthy people with periodontal disease and in people with osteopenia. The most significant impact of these two conditions is on the distance from the enamel-cement junction to the limbus alveolaris. Hence, the enormous importance of timely treatment of these two diseases in order to prevent significant loss of alveolar bone is also needed.

REFERENCES

Ahlborg, H. G., Johnell, O., Nilsson, B. E., Jeppsson, S., Rannevik, G., & Karlsson, M. K. (2001). Bone loss in relation to menopause: a prospective study during 16 years. Bone, 28(3), 327-331.

Anbinder, A. L., Moraes, R. M., Lima, G. M., Oliveira, F. E., Campos, D. R., Rossoni, R. D., ... & Elefteriou, F. (2016). Periodontal disease exacerbates systemic ovariectomy-induced bone loss in mice. Bone, 83, 241-247.

Dave, R. D., Patel, T. S., Patel, P. B., Patel, P., Dudhia, B., & Bhatia, P. (2023). Prediction of osteoporosis in men and women through orthopantomograph. *Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology*, *8*(4), 193-199.

Dhanya, M., Kumar, J., Ramalingam, K., & Vadivel, J. K. (2023). Effectiveness of Orthopantomograms as a Screening Tool for Osteoporosis: A Case-Control Study. Cureus, 15(9).

Effrianto, H. P. S., Priminiarti, M., & Makes, B. N. (2017, August). Mean alveolar bone crest height decrement in subjects with an osteoporosis risk. In *Journal of Physics: Conference Series* (Vol. 884, No. 1, p. 012051). IOP Publishing.

Genco, R. J. (1996). Current view of risk factors for periodontal diseases. Journal of periodontology, 67, 1041-1049.

Grossi, S. G., Genco, R. J., Machtet, E. E., Ho, A. W., Koch, G., Dunford, R., ... & Hausmann, E. (1995). Assessment of risk for periodontal disease. II. Risk indicators for alveolar bone loss. *Journal of periodontology*, *66*(1), 23-29.

Kanis, J. A., Burlet, N., Cooper, C., Delmas, P. D., Reginster, J. Y., Borgstrom, F., ... & European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO). (2008). European guidance for the diagnosis and management of osteoporosis in postmenopausal women. *Osteoporosis international*, *19*, 399-428. Albandar, J. M., & Rams, T. E. (2002). Global epidemiology of periodontal diseases: an overview. *Periodontology 2000*, *29*(1).

Kumar, D. P., Jayachandran, S., & Thilagavathy, N. (2021). Diagnostic validity of orthopantomogram compared to dual energy X-ray absorptiometry scan in detecting osteoporosis. *Annals of the National Academy of Medical Sciences (India)*, *57*(02), 100-107.

Lin, T. H., Lung, C. C., Su, H. P., Huang, J. Y., Ko, P. C., Jan, S. R., ... & Liaw, Y. P. (2015). Association between periodontal disease and osteoporosis by gender: a nationwide population-based cohort study. *Medicine*, *94*(7), e553.

Linden, G. J., Linden, K., Yarnell, J., Evans, A., Kee, F., & Patterson, C. C. (2012). All-cause mortality and periodontitis in 60–70-year-old men: a prospective cohort study. *Journal of clinical periodontology*, *39*(10), 940-946.

Looker, A. C., Orwoll, E. S., Johnston JR, C. C., Lindsay, R. L., Wahner, H. W., Dunn, W. L., ... & Heyse, S. P. (1997). Prevalence of low femoral bone density in older US adults from NHANES III. *Journal of Bone and Mineral Research*, *12*(11), 1761-1768.

López López, J., Estrugo Devesa, A., Jané Salas, E., Ayuso Montero, R., & Gómez Vaquero, C. (2011). Early diagnosis of osteoporosis by means of orthopantomograms and oral x-rays: a systematic review. *Medicina Oral, Patología Oral y Cirugia Bucal*, *2011*, *vol. 16*, *num. 7*, *p. 905-913*.

Navabi, N., Motaghi, R., Rezazadeh, M., & Balooch, H. (2018). Relationship between two panoramic radiography indices and bone mineral density of postmenopausal women with osteopenia and osteoporosis. *Journal of Dentistry*, *19*(3), 181.

Persson, G. R., Berglund, J., Persson, R. E., & Renvert, S. (2011). Prediction of hip and hand fractures in older persons with or without a diagnosis of periodontitis. Bone, 48(3), 552-556.

Porter, J. L., & Varacallo, M. (2023). Osteoporosis. In StatPearls. StatPearls Publishing.

Rehman, D. E., Qureshi, S., & Haq, A. (2014). Early detection of osteoporosis from incisure depth of human mandible in an orthopantomogram. *JPMA. The Journal of the Pakistan Medical Association*, *64*(7), 766-769.

Richa, Puranik, M. P., & Shrivastava, A. (2017). Association between osteoporosis and periodontal disease among postmenopausal Indian women. *Journal of investigative and clinical dentistry*, *8*(3), e12223.

Savic Pavicin, I., Dumancic, J., Jukic, T., Badel, T., & Badanjak, A. (2014). Digital orthopantomograms in osteoporosis detection: mandibular density and mandibular radiographic indices as skeletal BMD predictors. *Dentomaxillofacial Radiology*, *43*(7), 20130366.

Sczepanik, F. S. C., Grossi, M. L., Casati, M., Goldberg, M., Glogauer, M., Fine, N., & Tenenbaum, H. C. (2020). Periodontitis is an inflammatory disease of oxidative stress: We should treat it that way. Periodontology 2000, 84(1), 45-68.

Sharma, S., Agarwal, A., & Singh, C. (2020). Osteoporosis: detection using dental radiography. *J Dent Oral Sci*, *2*(3), 1-7.

Taguchi, A., Asano, A., Ohtsuka, M., Nakamoto, T., Suei, Y., Tsuda, M., ... & OSPD International Collaborative Group. (2008). Observer performance in diagnosing osteoporosis by dental panoramic radiographs: results from the osteoporosis screening project in dentistry (OSPD). *Bone*, *43*(1), 209-213.

Varacallo, M., Seaman, T. J., Jandu, J. S., & Pizzutillo, P. (2023). Osteopenia. In StatPearls. StatPearls Publishing.

Vlasiadis, K. Z., Skouteris, C. A., Velegrakis, G. A., Fragouli, I., Neratzoulakis, J. M., Damilakis, J., & Koumantakis, E. E. (2007). Mandibular radiomorphometric measurements as indicators of possible osteoporosis in postmenopausal women. *Maturitas*, *58*(3), 226-235.

Wang, C. W., & McCauley, L. K. (2016). Osteoporosis and periodontitis. *Current osteoporosis reports*, *14*, 284-291.

World Health Organization. (2004, May). WHO scientific group on the assessment of osteoporosis at primary health care level. In *Summary meeting report* (Vol. 5, pp. 5-7).

Yu, B., & Wang, C. Y. (2022). Osteoporosis and periodontal diseases–An update on their association and mechanistic links. *Periodontology 2000*, *89*(1), 99-113.