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THE PREVALENCE OF PERIODONTAL DISEASE IN POSTMENOPAUSAL WOMEN WITH OSTEOPOROSIS

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Abstract
Osteoporosis is more common in women, particularly after menopause and may be associated with oral health alterations. The aim of this study was to determine the relationship between periodontal disease and osteoporosis in postmenopausal women. Materials and method: During 2018-2020, 97 menopausal patients were studied, aged between 47 and 76 years: (1) with osteoporosis, mean age 62.42±7.85 years and (2) control group without osteoporosis, mean age 56.80±7.00 years. In group (1), the regions of interest were lumbar spine (L1-L4), proximal femur and mandible. Results: Mean lumbar BMD was 0.87 in group 1, 0.96 in group 2, femoral neck BMD 0.80 in group 1 and 0.88 in group 2, mandibular BMD 1.22 in group 1 and 1.27 in group 2 ($p<0.05$). Conclusions: Postmenopausal women with osteoporosis are six times more likely to have periodontal disease. Decreased bone mineral density is negatively correlated with the risk of developing periodontal disease.
Key words: osteoporosis, postmenopausal women, periodontitis.

Introduction

Osteoporosis is more common in women, particularly after menopause and may be associated with alterations in oral health status[1]. It is characterized by compromised bone strength, which predisposes to an increased risk of fractures. In osteoporosis, decreased bone mineral density affects bone quality with deterioration of oral tissues[2].

Periodontal disease comprises the inflammation of the supporting tissues of the teeth[3] and is defined as a complex chronic progressive and destructive inflammatory process that affects one, more or all four components of the tooth support apparatus: gum, alveolar bone, desmodontium, root cementum.

Osteoporosis, being a generalized disease, is not only limited to bone tissues traditionally explored with Dual X-ray Absorptometry (DXA), but also occurs in the facial bones. The oral consequences of osteoporosis are excessive resorption of the residual ridge, loss of teeth, maxillary sinus pain, chronic destructive periodontal disease and fracture. Marginal periodontitis, a widespread pathology, has a complex aetiopathogenesis that is still insufficiently elucidated. Studies in the literature regarding the possible involvement of osteoporosis in marginal periodontitis are few, contradictory and sometimes inconclusive[4]. There is also a lack of methods standardisation for assessing bone density, particularly in the jaws, and the determination of the accuracy and precision of these methods.

There are studies in the international literature showing a possible influence of systemic osteoporosis on periodontal health and therefore on jaw health.. Studies have indicated that osteoporosis, exaggerates the loss of alveolar bone[5].

The aim of this study was to determine the relationship between periodontal disease and osteoporosis in postmenopausal women. The present study occurred from the research of the literature in the field focused on the relatively high prevalence of periodontal disease among women suffering from osteoporosis. Given that the effects of systemic osteoporosis in oral pathology are insufficiently studied, especially in the Romanian population, we proposed this approach. The objectives of the research were to study the frequency of periodontal damage in a female population at menopause according to the presence or absence of osteoporosis.

Sample and methodology

We studied, between 2018 to 2020, a number of 97 menopausal patients, aged between 47 and 76 years, under the care of the Endocrinology Clinic in Cluj-Napoca, who were divided into 2 groups, one with osteoporosis, of 62 patients, with a mean age of 62.42±7.852 years and a control group without osteoporosis, of 35 patients, with a mean age of 56.80±7.003 years. We considered menopause as the definitive cessation of menstruation as a result of loss of ovarian activity.

The diagnosis of osteoporosis was based on the World Health Organization definition, based on BMD (Bone Mineral Density), which compares a patient's bone density with standard values in a population aged 20-40 years of the same sex and race.

The results were expressed as absolute BMD values in g/cm2 and as a T-score for the lumbar spine and proximal femur. The latter relates the BMD value obtained in the subject studied to the ideal maximum bone capital, i.e. the average BMD of a young subject of the same sex and race, and expresses it as the number of standard deviations from the average value.

Therefore, the calculation formula applied in determining the T-score is:

[BMD (g/cm²) patient]-[BMD (g/cm²) young adult] / standard deviation (SD)

Given the absence of a national reference population to which DXA results can be reported, data from NHANES (National Health and Nutrition Examination Survey) III were taken into account in the calculation of the T-score.

The presence of a T score ≤-2.5 SD at the lumbar spine and/or femoral neck and/or total hip was definitive for the diagnosis of osteoporosis in the subjects studied. In contrast to the spine and hip, the absence of a population-level reference group did not allow the results obtained to be expressed as a T-score at the mandible.

Osteoporotic bone tissue has a density more than 2.5 SD below the mean value (T-score<-2.5). Osteopenic tissue has a T-score between -2.5 and -1. Normal bone has a BMD T-score of -1 or higher89.

The regions of interest considered in the study group were the lumbar spine (L1-L4 segment), the proximal femur (femoral neck, trochanter and total hip) and the mandible.

The measurement of the spine was performed with the patient in a clinostatic position, with both legs elevated at ca. 80-90˚ to the body, knees flexed and supported on a dedicated support. This position ensures alleviation of physiological lumbar lordosis and allows optimal assessment of the L1-L4 region.

Hip assessment was also performed with the patient in clinostatic position with the lower limbs slightly apart and internally rotated.

In the case of the lumbar spine and hip, the analysis of the assessed regions was performed automatically using the dedicated

spine and hip software of the DPX NT Bone Densitometer machine.

In the mandible evaluation, the patient was positioned with the cephalic end rotated to the left and with her mouth wide open.

In the case of mandibular DXA, the current absence of a software version dedicated to the evaluation of this region of interest required the use of distal forearm software in the measurement, with subsequent analysis performed manually by manually defining the contour of the mandibular bone in each case. The amount of bone mineral obtained was related to the measured area, resulting in the mandibular bone density (g/cm2) .

Regarding the presence of periodontal disease, it was necessary to identify a set of objective clinical signs (gingival recession, tooth mobility), which can allow a quicker orientation in establishing the attachment loss and successive, the diagnosis of periodontal disease. It was also aimed at detecting some parameters that could capture as accurately as possible the periodontal status, such as the gingival index and the periodontal index. As a paraclinical examinations of panoramic radiographies were performed.Gingival retraction, an indicator of ligamentous tissue smoothness and apical migration of periodontal tissue sheath, was measured as the distance between the anatomical tooth collar (cemento-enamel junction) and the gingival margin.

Tooth mobility was determined using two metal instruments (the handle of a dental probe and a mirror). We did not check mobility directly, with the finger, as it is depressible and the examination took on an increased note of subjectivity. Pathological tooth mobility we assessed according to the 3 degrees of severity:

o 1st degree = mobility in the buccal-oral direction, not exceeding 1 mm;

o 2nd degree = vestibulo-oral and mesio-distal mobility exceeding 1 mm;

o 3rd degree = horizontal mobility associated with vertical.

We eliminated other causes of dental mobility, such as occlusal trauma and physiological resilience, which has values between 0.10 and 0.15 mm .

The gingival index (Loe and Silness) is an index of gingival inflammation and is based on changes in consistency, colour and presence of bleeding; it is expressed by the following classification:

0=gingiva with normal clinical appearance;

1=gingiva with mild inflammation, slight colour changes, slight oedema, no bleeding on probing;

2=medium swelling, congestion, oedema, bleeding on probing;

3=advanced inflammation, congestion, stasis, ulceration, spontaneous bleeding.

The Periodontal Index (Russell) assesses both the condition of the gingiva and the supporting periodontium using a scale from 1 to 8 as follows:

0= absence of gingival inflammation and in the deep periodontium;

1= moderate gingivitis that does not circumscribe the tooth collar;

2= advanced gingivitis, circumscribing the tooth collar, with no apparent damage to the epithelial insertion;

6= gingivitis with pockets and destruction of the epithelial insert; teeth are still well implanted, mastication is still normal. Radiologically there is loss of alveolar bone mass, up to half the root length;

8= advanced destruction of periodontal bone, severe mastication disorders, dull sound when teeth are drilled with a metal instrument, axial tooth mobility.

All patients underwent a radiological investigation: panoramic radiography, performed at the Department of Radiology

University of Medicine and Pharmacy Cluj, with the device Orthopantomograph OP 100 [GE Healthcare]. The following elements were examined: degree and type of alveolar bone resorption (vertical, horizontal, mixed), these also guiding on the lesional type (inflammatory, dystrophic, associated).

The essential elements that we followed in the radiological examination were, according to Meyer's recommendations, the following: lamina dura, buccal and oral bone corticals, bone trabeculae, desmodontal space, degree and shape of alveolysis.

We considered the following clinical and radiological elements: normally the alveolar ridge - the hard lamina starts from the mesial face of a tooth, from a point located approximately 1-2 mm from the enamel-cement junction and going to the distal face of the adjacent tooth, having a path parallel to an imaginary line joining the enamel-cement boundary of the same two teeth. The cortical line of the interdental septum in healthy alveolar bone appears as a thin, fine, continuous line, forming a sharp angle with the root of the adjacent tooth with a very small opening.

Horizontal bone resorption, a dystrophic-pure lesion, has been diagnosed radiologically as irregular radiolucencies in the alveolar septa.

Vertical bone resorption, has been diagnosed on the basis of the radiological appearance of "funnel", "ladder", "sink", with the lamina dura being destroyed in all forms; in severe cases, bone resorption spreads to the proximal faces of the alveolus, but also to the apex, resulting in a radiological appearance of a stretched radiolucency, in the centre of which the tooth seems to "float" - total bone destruction.

The mixed (associated) lesional type, which occurs in most patients with advanced bone damage, has been diagnosed on the basis of the background appearance of horizontal atrophy, onto which vertical lesions are grafted in each group of teeth.

We set out to establish the following relationships:

- between osteoporosis and frequency of periodontal disease;

- between bone mineral density at different levels and the presence of periodontitis.

The patients included in the study were informed about the relevant aspects of the study and on the basis of this information, they gave their written consent to participate. Ethical approval for this study was obtained from Iuliu Hatieganu University of Medicine and Pharmacy. Each patient was provided with a research form in which personal data, clinical, radiological and DXA examination results were recorded. Medcalc version 12.3 software was used for statistical analysis.

Data were labelled as nominal, ordinal, dichotomous and continuous variables. The normality of the distribution of continuous variables was tested by the Kolmogorov-Smirnov test. For the description of normally distributed variables we calculated the mean±standard deviation. For univariate analysis of normally distributed variables we used the t-test for independent variables (for dichotomous variables), Pearson correlation (for continuous variables) and ANOVA test (for nominal variables). For the analysis of ordinal variables we used Spearman's rho correlation. As a threshold of statistical significance we set the p parameter at 0.05.

The study was analytical, cross-sectional, observational and case-control.

Results

The relationship between osteoporosis and frequency of periodontal disease

The 97 postmenopausal patients were divided on the basis of objective clinical

signs, indices and radiological aspects into two categories: with periodontal disease (74 patients) and without periodontal disease (23 patients) (Table I).

Table I. The relationship between the presence or absence of osteoporosis and the frequency of periodontal disease in postmenopausal women.

				p
		Without periodontal	With periodontal	
Sample	Without	16	19	<0,001
	With osteoporosis	7	55	

Patients with osteoporosis had statistically significantly more frequent high periodontal disease than those without osteoporosis. Since it is a case-control study Odds Ratio is preferred as a proxy for relative risk and the obtained value of 6.62 was statistically significant, as both the uncorrected value and the values with Mantel-Haenszel and Yates corrections of the chi-square test were below 0.05. Thus, patients with osteoporosis were 6.6 times more likely to have periodontal disease than those without osteoporosis.

Since the Levene test for equality of variances showed that there are no statistically significant differences in variances between the two groups, the Student's t-test for equal variances was used, whose probability $p<0.05$ showed that there were significant differences between the mean values of L1-L4 BMD, femoral neck BMD and total hip BMD between the group of postmenopausal women with periodontal disease and the group without periodontal disease. For mandibular BMD, no statistically significant differences were found between the two groups (Table II).

The relationship between BMD at different levels and periodontal disease

Table II. The analysis of the relationship between BMD at various levels and the presence or absence of periodontal disease in postmenopausal women.

Variable	Periodontal disease diagnosis	N	Mean	Standard Deviation	p
BMD L1-L4	Without periodontal disease	23	0,96	0,14	0,007
	With periodontal disease	74	0,87	0,13	
BMD Femoral neck	Without periodontal disease	23	0,88	0,10	0,006
	With periodontal disease	71	0,80	0,10	

BMD Total hip	Without periodontal	23	0,92	0,14	0,039
	With periodontal disease	71	0,86	0,11	
BMD Mandible	Without periodontal disease	17	1,27	0,29	0,482
	With periodontal disease	39	1,22	0,21	

Student's t-test for unequal variances was performed, whose probability $p<0.05$ showed that there were significant differences between the mean values at the three levels, L1-L4 BMD, femoral neck BMD and total hip BMD, in the group with periodontal disease and without periodontal disease.

Discussions

Establishing the diagnosis of marginal periodontal disease is a challenging issue, which includes a clinical and radiographic diagnosis, the new classification system being developed by the World Workshop on the Classification of Periodontal and Peri-Implant Disease in 2017[6].

In our study we observed that patients with osteoporosis presented six times more frequently periodontal disease than those without osteoporosis. We also observed that as bone mineral density decreases, the likelihood of developing periodontal disease increases. Thus, at the L1-L4 level we have a mean BMD of 0.96±0.14g/cm² in people without periodontal disease compared to 0.87±0.13 g/cm² in people with periodontal disease. At the femoral neck, we found an average of 0.88±0.10 g/cm² in people without periodontal disease, compared to 0.80±0.10 g/cm² in people with periodontal disease. At total hip level we found a mean BMD of 0.92±0.14 g/cm² in people without periodontal disease compared to 0.86±0.11 g/cm² in people with periodontal disease.

Student's t-test for unequal variances was performed, whose probability $p<0.05$ showed that there are significant differences between the mean values at the three levels, BMD L1-L4, BMD femoral neck and BMD total hip, in the group with periodontal disease and without periodontal disease. For mandibular BMD, differences were found for the two categories, i.e. 1.27±0.29 g/cm² in the patients without periodontal disease compared to 1.22±0.21 g/cm² in those with periodontal disease, but not statistically significant ($p=0.482$).

Our data are in agreement with those from the international literature. We did not find any data on this issue in the country, thus not being able to make a comparison.

Periodontal disease and osteoporosis are common chronic diseases, especially for the women in postmenopause[7].

The severity of osteoporosis is more in women during menopause[8].

In postmenopausal women, the presence of symptomatic periodontal disease may decrease the effect of medications for osteoporosis[9].

The possible correlation between general systemic osteoporosis and alveolar bone loss in the pathogenesis and progression of periodontal disease has been studied since the 1970s. These studies have shown that there is no clear correlation between periodontal health and overall skeletal mineral levels. In a recent study on a possible correlation between osteoporosis and

periodontal disease, Von Wowern et al. studied BMD of the mandible and forearm in a group of women with osteoporosis and a control group. The osteoporosis group had significantly lower mandibular and forearm BMD values than the control group. There were no significant differences in plaque and gingival bleeding, but women with osteoporosis showed a greater loss of gingival attachment[10].

Osteoporosis is a risk factor for periodontal disease and has an important role in disease progression[11].

Several studies[12,13,14,15,16,17] have shown a positive correlation between osteoporosis and oral cavity disease. Patients with osteoporosis have a greater number of teeth extracted, show a greater decrease in BMD in the mandible and condyles and an accelerated rate of residual alveolar ridge resorbtion compared to the general population[18,19]. It has also been suggested that there is a correlation between BMD or reduced skeletal mass and reduced alveolar ridge height, as well as with loss of clinical junction[20].

Postmenopausal osteoporosis is often a consequence of estrogen (E2) deficiency. Estrogen deficiency alters the metabolism of gum junction tissue, resulting in periodontal disease. Osteoporosis/osteopenia and estrogen deficiency are risk factors for loss of alveolar bone density in postmenopausal women with periodontal disease. There is also a growing body of evidence linking estrogen levels, alveolar BMD loss and periodontal disease. Furthermore, there is evidence that some forms of periodontal disease may be exacerbated by osteoporosis[17,21,22,23].

The aim of a study by Payne et al. was to analyze posterior vertical bite wing radiographs using CADIA, taken initially and at one year, on a sample of a postmenopausal, E2-sufficient and E2-deficient female population. The study focused on analyzing changes in alveolar bone density to determine whether alveolar bone is similar to skeletal bone in terms of longitudinal density loss in E2-deficient women. The results indicated that the vast majority of posterior interproximal areas in these subjects exhibited forms of periodontal disease. Overall interproximal changes revealed that E2-sufficient women showed an average increase in alveolar bone density compared to E2-deficient women, who showed an average loss. Increased loss of alveolar bone density in molar regions demonstrates an increased susceptibility of molars to loss of gingival attachment or even their own. The E2 level cannot be considered as the only factor influencing the change in bone density. Other factors, such as the ability of a patient or doctor to reduce the local microflora in a particular region of the oral cavity, must be taken into account. E2 deficiency, however, may be a risk factor for alveolar bone density loss[24].

Another study set out to show the relationship between osteoporosis and tooth loss, using correlations between tooth loss and spinal bone density. The relationship between clinical periodontal status and spine bone density was also examined. The severity of periodontitis was significantly associated with spine bone density; the lower the bone density, the more severe the periodontitis[25,26].

Krall et al. reported that loss of teeth may be associated with an increased risk of low bone mineral density in healthy postmenopausal women[27]. Penoni et al. reported that postmenopausal women with osteoporosis may exhibit greater clinical attachment loss compared with women with normal bone mineral density[28].

In a study conducted to assess a possible link between systemic bone mass and periodontitis in a large group of women aged 46-55 years in Amsterdam, no significant correlation was observed between clinical parameters of periodontitis and skeletal bone mass measurements. In

conclusion, no relationship was established between the occurrence of periodontitis and skeletal bone mass. This suggests that bone mass does not play an important role in the development of periodontal disease. However, it cannot be excluded that, if periodontal disease is present, total skeletal bone mass correlates with disease severity and severity[29].

Megson et al. found in a recent study that low BMD is a risk factor in the development of periodontal disease[30]. Also, in a recent study Habashneh et al. demonstrated that osteoporosis is correlated with the prevalence of periodontal disease in postmenopausal women[31]. Passos et al. found similar results, especially in patients with osteoporosis without medication[32].

Decreased bone mineral density in ageing women, could attribute to higher degree of periodontal tissue destruction[2].

Conclusions

1. Postmenopausal women with osteoporosis are six times more likely to have periodontal disease than those without osteoporosis.
2. Decreased bone mineral density at L1-L4, femoral neck and total hip correlates negatively and statistically significantly with the risk of developing periodontal disease.

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