



Prevalence of apical periodontitis in postmenopausal women with osteoporosis: A retrospective study

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Purpose: The aim of this study was to compare the prevalence of apical periodontitis (AP) between postmenopausal women diagnosed with osteoporosis (OP) and systemically healthy postmenopausal women, representing a Mediterranean subpopulation.

Methods: The study included 71 postmenopausal women aged between 50 and 70 years. Based on dual-energy X-ray absorptiometry (DEXA) results, participants were classified into two groups: osteoporotic and healthy. Panoramic radiographs of each subject were evaluated for the presence of AP and scored using the periapical index (PAI). Additionally, the decayed, missing, and filled teeth (DMFT) index, the number of root canal-treated (RCT) teeth, and smoking status were recorded. Statistical analysis was performed using the independent samples t-test, Mann–Whitney U test, and Chi-square tests ($p < 0.05$). Interobserver agreement was found to be high ($\kappa = 0.86$).

Results: No statistically significant differences were observed between osteoporotic and systemically healthy postmenopausal women in terms of AP prevalence, PAI scores, DMFT index, or the number of RCT teeth ($p > 0.05$).

Conclusion: The findings suggest that OP may not be an independent risk factor for the development of apical inflammation in postmenopausal women. From a clinical perspective, pharmacologically managed OP does not appear to negatively affect endodontic prognosis. Further comprehensive, multicenter studies are warranted to better understand the impact of systemic bone diseases on periapical inflammation.

Keywords: Apical periodontitis; DMF index; dual-energy X-ray absorptiometry; osteoporosis; panoramic radiography; postmenopausal woman.

Introduction

Apical periodontitis (AP) is an inflammatory disease characterized by the formation of an osteolytic lesion at the root apex, triggered by polymicrobial colonization of the root canal system (1). These lesions arise as a result of cel-

lular and humoral responses generated by the host defense system to eliminate microorganisms. Infectious stimuli activate various immune cells, particularly neutrophils and macrophages, leading to the production of numerous cytokines and chemokines that orchestrate the inflammatory

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process. In this context, mediators such as interleukin-1 β (IL-1 β), interleukin-6 (IL-6), tumor necrosis factor- α (TNF- α), and receptor activator of nuclear factor kappa-B ligand (RANKL) are among the key molecular mediators involved in periapical tissue destruction (2). The clinical course of AP may vary depending on the host's immune response capacity; the duration of infection and the balance of immune regulatory mechanisms play a decisive role in whether the lesion develops in an acute or chronic form (3).

Numerous studies in the literature have explored the bidirectional relationship between AP and systemic health (4,5). It has been demonstrated that AP is not confined to a local inflammatory response but also contributes to elevated levels of systemic inflammatory cytokines and induces molecular damage at the cellular level through oxidative stress (6). These biological mechanisms have the potential to contribute to the pathogenesis of systemic diseases, thereby necessitating the consideration of AP not merely as an oral infection but as an inflammatory focus with potential systemic implications. Current evidence suggests that AP may be associated with metabolic disorders such as diabetes mellitus and osteoporosis (OP) (7,8), autoimmune diseases including hepatitis, rheumatoid arthritis, and nephritis (9,10), cardiovascular diseases (4), hepatic dysfunction (11) and even adverse pregnancy outcomes (12).

OP is an age-related systemic skeletal disorder characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to increased bone fragility (13). Depending on the factors affecting bone metabolism, OP is classified as primary—comprising postmenopausal (type I) and senile (type II) forms—and secondary, which develops because of systemic diseases, medications, or lifestyle-related factors (14). In the general population, the lifetime risk of osteoporotic fractures is reported to be approximately 40–50% in women and 13–22% in men (15). Postmenopausal women represent the highest risk group due to a marked decrease in estrogen levels accompanied by an increase in follicle-stimulating hormone (FSH); these hormonal changes trigger osteoclast-mediated bone resorption, thereby accelerating bone loss (16–18). AP and OP are bone-related diseases that share similar characteristics in terms of their inflammation-associated pathogenesis and their interaction with the aging process. Low bone mineral density has been proposed as a predisposing factor in the progression of periapical lesions. The presence of common mediators, risk factors, and biological pathways in the pathophysiological mechanisms of these two conditions renders the investigation of a potential relationship between OP and AP scientifically

meaningful (19).

Although some evidence in the current literature suggests that OP may increase the risk or severity of AP, particularly in female patient populations, data supporting a strong and consistent association between these two conditions remain limited (20–23). Heterogeneity among findings, methodological variations, and sample diversity limit the generalizability of the results. Therefore, the aim of this retrospective study was to compare the prevalence of AP between postmenopausal women diagnosed with OP and systemically healthy postmenopausal women representing a Mediterranean subpopulation. The null hypothesis of the study was that there would be no statistically significant differences between osteoporotic and healthy postmenopausal women in terms of the number of AP cases, periapical index (PAI) scores, DMFT index (number of decayed, missing, and filled permanent teeth), or the number of root canal-treated (RCT) teeth.

Materials and Methods

Study Design and Ethical Approval

This retrospective observational study was approved by the Non-Interventional Clinical and Observational Research Ethics Committee of the Faculty of Dentistry, Alanya Alaaddin Keykubat University (No: 4-5, Date: 12/02/2025). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Anamnesis records, panoramic radiographs, and dual-energy X-ray absorptiometry (DEXA) bone mineral density measurements of all participants were retrospectively retrieved from the institution's digital archive system. All patients were adequately informed about the purpose of the study during the diagnostic and treatment process, and their written informed consent was documented in their medical files.

The sample size was determined using G*Power software (Version 3.1.9.7; Düsseldorf, Germany), based on a previously published study with a similar methodology (24). According to the power analysis, a minimum of 56 participants was required to achieve a statistical power ($1-\beta$) of 0.95 with an effect size of 0.90 and a significance level (α) of 0.05. Considering potential data loss, exclusion criteria, and observational variability, the sample size was expanded. Ultimately, a total of 71 participants were included in the study, consisting of 31 postmenopausal women diagnosed with OP and 40 systemically healthy postmenopausal women.

Sample Selection and Inclusion Criteria

Within the scope of this study, medical records of post-

menopausal female patients aged between 50 and 70 years, registered in the hospital information management system of Alanya Alaaddin Keykubat University Faculty of Dentistry, were retrospectively reviewed. All included individuals had comprehensive medical anamnesis records, panoramic radiographic images, and DEXA measurements for the assessment of bone mineral density available in their digital files. During the diagnostic and treatment process, patients were informed about the procedures, and written informed consent was obtained from each participant.

Participants were divided into two groups based on their systemic status: The study group consisted of individuals diagnosed with primary OP (25), while the control group included systemically healthy individuals without a diagnosis of OP. The groups were selected to have a similar distribution in terms of age, menopausal status, socioeconomic level, and smoking habits. The inclusion criteria for both groups are summarized in Table 1.

Radiographic Evaluation and Diagnostic Criteria for Apical Peridontitis

Medical history, diagnostic, and treatment data of all patients were retrieved from the hospital information system and transferred to a standardized Excel database. Panoramic radiographic evaluations were performed using images obtained with a single device (Planmeca ProMax® 2D S3, Planmeca Oy, Helsinki, Finland). Radiographs were selected based on sufficient image quality and inclusion of the entire dentition. Third molars were excluded from the analysis. For each patient, the number of AP cases observed in both RCT and untreated teeth, PAI scores, DMFT index, and the number of RCT teeth were recorded. In addition, smoking status was classified as a binary variable (yes/no).

PAI scoring was performed based on the five-point system developed by Ørstavik et al. (26), which evaluates the radiographic characteristics of periapical tissues. Score 1 indicates normal periapical structures; score 2 corresponds to a slight widening of the periodontal ligament space; score 3

represents a radiolucency with some changes in bone structure but with poorly defined borders; score 4 denotes a well-defined, round or oval radiolucency at the root apex; and score 5 reflects a large, clearly defined radiolucency. All panoramic radiographs were independently assessed by two observers (G.P.Y. and M.F.) with clinical experience in endodontics. Prior to evaluation, the observers underwent standardization training, and all assessments were performed according to pre-defined criteria. To assess interobserver reliability, statistical analysis was conducted. Agreement between the two observers regarding PAI scores was found to be high, with a Cohen's kappa coefficient of 0.86, indicating excellent interobserver agreement.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics software (version 26; IBM Corp., Armonk, NY, USA). The Kolmogorov–Smirnov and Shapiro–Wilk tests were used to assess the normality of data distribution. Since the variables for the number of AP cases, PAI scores, and RCT counts did not follow a normal distribution, intergroup comparisons for these variables were conducted using the Mann–Whitney U test. For the DMFT index, which was normally distributed, the independent samples t-test was applied. The Chi-square test and Fisher's exact test were used for categorical variables. A significance level of $p < 0.05$ was considered statistically significant for all tests.

Results

No statistically significant differences were found between postmenopausal women diagnosed with OP and systemically healthy postmenopausal women in terms of the number of AP cases, PAI scores, DMFT index, or the number of RCT teeth ($p > 0.05$). Similarly, the distribution of smoking status did not differ significantly between the groups. Interobserver agreement was high, with a Cohen's kappa coefficient calculated at 0.86. Detailed data regarding these findings are presented in Table 2.

Table 1. Inclusion criteria for the OP and control groups

Criteria	OP group	Control group
Age range	50–70 years old	50–70 years old
Menopausal status	Postmenopause	Postmenopause
Systemic disease status	No systemic disease other than OP	Systemically healthy
OP diagnosis	DEXA T score ≤ -2.5 and primary OP diagnosis is present	No OP detected with DEXA (T score ≥ -1)
OP treatment duration	Have been treated with any OP medication for ≥ 1 year	Not received OP treatment
Radiographic recording	Panoramic radiography available	Panoramic radiography available
Socioeconomic status and smoking	Similar to the control group	Similar to the study group

*DEXA: Dual-energy X-ray absorptiometry; OP: Osteoporosis.

Table 2. Radiographic parameters compared between osteoporotic and systemically healthy postmenopausal women

Variable	OP Group	Control Group	p value
AP Number (Mean ± SD)	1.29±1.24	1.95±2.05	0.178
PAI Score (Mean ± SD)	2.80±1.32	2.89±1.38	0.796
DMFT Score (Mean ± SD)	22.58±9.58	21.60±7.21	0.624
RCT Number (Mean ± SD)	1.87±1.88	1.53±1.65	0.414
Smoking (n, %)	3 (9.7)	3 (7.5)	0.744

*AP: Apical periodontitis; DMFT: Number of decayed, missing, and filled permanent teeth; OP: Osteoporosis; PAI: Periapical index; RCT: Root canal-treated; SD: Standard deviation, Smoking was considered as a “yes” category. $p < 0.05$ was considered statistically significant.

Discussion

In this retrospective study, the prevalence of AP and various radiographic parameters were compared between postmenopausal women diagnosed with OP and systemically healthy counterparts. The results supported the null hypothesis proposed prior to the study, as no statistically significant differences were found between the groups for any of the evaluated parameters. This finding suggests that OP may not be an independent determinant in the development or severity of periapical inflammation. However, the literature includes studies reporting conflicting results. Some have proposed that alterations in bone metabolism may influence the host response in the periapical region, potentially resulting in larger or more persistent lesions in osteoporotic patients. Nonetheless, it is important to recognize that such outcomes can be influenced by various factors, including patient selection criteria, systemic variability of OP, imaging modalities used, and the presence of comorbid systemic conditions. In the present study, a clearly defined age range and a systemically homogeneous population consisting exclusively of female subjects were evaluated, thereby providing data that help reduce the methodological heterogeneity observed in the existing literature.

The inclusion of postmenopausal women aged 50 to 70 years in the present study was planned with consideration of the potential diagnostic implications of the pathophysiological differences among OP subtypes. This age range represents a period during which postmenopausal OP is characterized by a marked decline in bone mineral density and increased fracture risk, yet precedes the stage at which senile OP typically becomes predominant. In senile OP, which develops with advancing age, bone formation slows more noticeably, and mineral accumulation may lead to calcification foci within the bone. These calcifications can obscure the typical radiographic features of postmenopausal OP—especially in trabecular bones such as the vertebrae—thus causing diagnostic uncertainty. Moreover, the generalized and balanced cortical bone loss seen in

senile OP follows a different pattern from the trabecular bone degradation typically observed in postmenopausal OP (27). Therefore, to isolate the specific effects of postmenopausal OP and ensure the consistent application of diagnostic criteria, individuals in older age groups were excluded from the study. This approach aimed to assess the potential impact of OP on AP within a more homogeneous sample.

Several studies (21,28,29) have reported that AP progresses more rapidly and presents with greater severity in osteoporotic individuals, a finding that may be associated with increased bone resorption and altered inflammatory response profiles. López-López et al. (30) observed a marginal correlation between OP and radiolucent periapical lesions in postmenopausal patients, while Katz et al. (31) reported a higher prevalence of AP in osteoporotic individuals. Experimental studies conducted on animal models have also shown that OP may adversely affect periapical healing and significantly impair bone regeneration under osteoporotic conditions (32). In contrast, Cadoni et al. (24) concluded that OP does not play a significant role in the development of AP, emphasizing instead a potential relationship between altered healing dynamics in RCT teeth and the pharmacological treatments used by OP patients. Similarly, a cohort study conducted in Austria by Grun et al. (21) found no statistically significant difference in the prevalence of AP, either in endodontically treated or untreated teeth, associated with the presence of OP. Additionally, Alam et al. (33) reported no significant difference in PAI scores between postmenopausal women with OP and healthy controls. These findings are consistent with the results of the present study and suggest that OP may not be a directly influential factor in the development of apical lesions. This similarity supports the notion that, even when similar methodologies are applied across different geographic regions and patient populations, OP alone may not play a determinative role in the occurrence of AP.

In the present study, the DMFT index values of postmenopausal women diagnosed with OP did not differ significantly from those of systemically healthy individu-

als. This finding suggests that OP may not be a direct determinant of dental morbidity. Similarly, Grgic et al. (34) reported comparable DMFT values between postmenopausal women with OP undergoing bisphosphonate therapy and healthy postmenopausal controls. However, the same study emphasized that periodontal parameters were negatively affected, indicating that the impact of OP may be more pronounced on the periodontium (34). This suggests that systemic alterations in bone metabolism may not always be reflected in DMFT components, such as dental caries or restorations, but may elicit more sensitive biological responses at the level of periodontal tissues. Therefore, preventive oral health strategies become particularly important in the postmenopausal period.

The findings of the present study revealed that the number of RCT teeth in postmenopausal women diagnosed with OP did not differ significantly from that of systemically healthy individuals. To date, the existing literature lacks direct and conclusive evidence indicating a difference in the number of RCT teeth between postmenopausal women with OP and healthy controls. However, some studies have reported a higher frequency of invasive dental procedures among women diagnosed with OP (35). Root canal treatment is a commonly performed procedure in the general population, and its prevalence is influenced more by factors such as dental history, oral hygiene status, and access to care rather than systemic health alone (36). Therefore, more comprehensive and comparative studies are needed to clarify the potential impact of OP on the indication for root canal treatment.

In the treatment of OP, various pharmacological agents are available that aim to increase bone mineral density and reduce fracture risk. Among the most commonly used medications in Europe for this purpose are bisphosphonates, the RANKL inhibitor denosumab, estrogen, and selective estrogen receptor modulators (37,38). Considering their effects on bone metabolism, differences observed in the apical inflammatory response among osteoporotic patients may, in part, be attributed to biological variations induced by these pharmacological interventions. Specifically, bisphosphonates reduce bone resorption by suppressing osteoclast activity, and denosumab inhibits the RANKL pathway—both of which have the potential to influence the progression of periapical inflammation and the resolution of apical lesions (24,29). However, the findings related to these medications remain inconsistent in the literature, and their roles in the pathogenesis of AP have not yet been clearly defined. In the present study, all individuals diagnosed with OP had been under pharmacological treatment for at least one year, which may have contributed to the limited impact of OP on periapical tissues. This

factor could partially explain the absence of a statistically significant difference in AP prevalence between osteoporotic and healthy individuals. Therefore, future studies should consider the type, duration, and biological effects of OP medications as independent variables when evaluating their potential influence on periapical inflammation.

This study provides a valuable contribution to the literature by focusing exclusively on postmenopausal women with a clearly defined age range, well-characterized systemic health status, and a documented duration of pharmacological treatment. However, several methodological limitations should be acknowledged. These include the inherent constraints of the retrospective study design, radiographic method represents an inherent limitation. While panoramic radiographs were useful for standardized retrospective data collection, their two-dimensional nature limits the sensitivity of detecting apical lesions compared with periapical radiographs or cone-beam computed tomography (CBCT). In addition, although all patients with OP had been under pharmacological treatment for at least one year, detailed individual data regarding the specific type and duration of medication could not be obtained. Since agents such as bisphosphonates and denosumab directly affect bone resorption, the lack of detailed medication analysis limited our ability to assess correlations with bone resorption rates. Moreover, periodontal health data were not available in the present study, which further restricts interpretation of the results. These limitations have been highlighted to guide future research. Furthermore, the relatively limited sample size must be acknowledged, even though it was determined by power analysis. Larger, multicenter studies with broader populations are still necessary to reach more generalizable conclusions. In this context, future research should include prospective, multicenter studies that integrate clinical, radiographic, and biochemical data to more comprehensively elucidate the relationship between OP and AP.

Conclusion

In this retrospective study, no statistically significant differences were found in the prevalence of AP or radiographic parameters between postmenopausal women diagnosed with OP and systemically healthy individuals. The findings suggest that OP may not be an independent risk factor for apical inflammation. However, considering the limited sample size, the retrospective design, and the absence of detailed medication and periodontal health data, this conclusion should be interpreted with caution. To better understand the nature of this relationship, larger-scale, prospective, multicenter studies incorporating clinical, radiographic, pharmacological and periodontal data warranted.

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Informed consent: NA

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