HEALTH SCIENCE MONITOR

Health Science Monitor

Health Sci Mon 2025; 3: e251213
https://doi.org/10.5577/hsm.e251213

Original Article

Open Access

Evaluation of periapical healing in patients with osteoporosis: A retrospective study

Elçin Tekin Bulut[1], Levent Akıncı[2], Özge Turan[3], Yeşim Talay[4]

[1] İnönü University, Faculty of Dentistry, Department of Endodontics, Malatya, Türkiye
[2] Uşak University, Faculty of Dentistry, Department of Endodontics, Uşak, Türkiye
[3] Elazığ Oral and Dental Health Center, Elazığ, Türkiye
[4] Dörtyol Oral and Dental Health Center, Hatay, Türkiye

Received: 25 October 2025
Accepted: 22 November 2025
Published: 30 November 2025

Correspondence:

Dr. Elçin TEKİN BULUT
İnönü University, Faculty of Dentistry, Department of Endodontics, Malatya, Türkiye.
E-mail: elcin.bulut@inonu.edu.tr

How to cite this article:

Tekin Bulut E, Akıncı L, Turan Ö, Talay Y. Evaluation of periapical healing in patients with osteoporosis: A retrospective study. Health Sci Mon. 2025;3: e251213. https://doi.org/10.5577/hsm.e251213

Abstract

Aim: The aim of this retrospective study was to evaluate periapical healing after root canal treatment in patients with osteoporosis presenting with periapical lesions.

Methods: Thirty-five patients diagnosed with osteoporosis who were admitted to the Inonu University Faculty of Dentistry, Department of Endodontics, between January 2010 and September 2018 were initially screened. Three patients without periapical lesions, one patient whose radiographic records were unavailable, one patient who had received inadequate root canal treatment, eleven patients who were unreachable, and twelve patients who were unable to attend follow-up visits were excluded from the study. Consequently, 13 teeth from seven patients were included in the osteoporosis group. The control group consisted of systemically healthy individuals with periapical lesions. Demographic data, medical history, treatment type, and clinical and radiographic findings were recorded. The periapical status before and after treatment was evaluated using the Periapical Index (PAI) scoring system and the American Association of Endodontists' recommendations.

Results: Healing rates were compared between the groups using Fisher's exact test, and no statistically significant difference was observed ($p = 1.000$). Changes in periapical status according to PAI scores were analyzed using the Wilcoxon signed-rank test, revealing statistically significant improvements in both the control ($p < 0.001$) and the osteoporosis groups ($p = 0.002$). Comparisons of the pre- and post-treatment PAI scores between the groups using the Mann–Whitney U test demonstrated no statistically significant differences either before ($p = 0.947$) or after treatment ($p = 0.804$).

Conclusion: Periapical healing following root canal treatment did not differ significantly between patients with osteoporosis and healthy controls. However, further studies involving larger populations are required to confirm these findings.

Keywords: Osteoporosis, periapical index scoring, periapical healing, root canal treatment, apical periodontitis

Introduction

Apical periodontitis generally originates from a polymicrobial infection of the dental pulp and involves an inflammatory process with complex defense mechanisms. This inflammatory process leads to tissue damage, particularly alveolar bone resorption around the related tooth apex (1-4). Lesions of apical periodontitis, which mainly indicate structural changes in the alveolar bone, clinically present as periapical radiolucency. In periapical lesions, a local immune response involving the migration of inflammatory cells, production of cytokines, release of lytic enzymes, and activation of osteoclasts leads to alveolar bone resorption. Not only the formation of periapical lesions but also the healing process after root canal treatment is an immunological defense reaction of the host (5-8). Healing of periapical tissues, another biological process, aims to repair tissue damage, particularly bone loss, and occurs after the elimination of microbial infection following root canal treatment. As healing occurs through mechanisms involving the host's immune system following successful root canal treatment, it is also influenced by the presence of systemic factors such as age and chronic diseases (9, 10). In addition, the immune and skeletal systems are closely related because of their shared cellular origins and well-established roles in the cellular and molecular mechanisms involved in bone tissue formation and healing (11).

Osteoporosis is defined as "a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture" (12-14). Osteoporosis is a pervasive metabolic skeletal disorder characterized by systemic impairment of bone mass and microarchitecture. The pathophysiology involves a dysregulation in bone remodeling, resulting in a net loss of bone volume that disproportionately affects postmenopausal women. According to the International Osteoporosis Foundation (IOF), the global prevalence of the disease is substantial, estimated to affect between 200 and 300 million individuals. Consequently, the deterioration of trabecular microarchitecture and increased cortical porosity compromise bone fragility, thereby significantly elevating the risk of fractures (15-20). According to the Turkish Osteoporosis Society, the prevalence of osteoporosis in Türkiye was 17.1% among individuals aged 50–64 years and 33.7% among those aged ≥ 65 years, defined by a T-score ≤ −2.5, based on data collected in 2008–2009 (21). Changes associated with osteoporosis result from an imbalance in the bone remodeling process. As a major systemic disease, osteoporosis affects several sites of the skeleton as well as the alveolar bone (22-24).

Based on the existing literature, this study aimed to identify patients with osteoporosis treated and to evaluate the periapical wound healing of apical periodontitis lesions caused by primary or secondary endodontic infections.

Materials and Methods

The study protocol was approved by the İnonu University Health Sciences Research Ethics Committee (approval no. 2019/01-10). Patients with osteoporosis who had undergone root canal treatment between 2010 and 2018 were identified at the clinics of the Department of Endodontics, Faculty of Dentistry, Inonu University.

The case group comprised patients diagnosed with osteoporosis and no other systemic disease; however, three patients with a history of breast cancer were also included. A detailed overview of the workflow for establishing the case and control groups is shown in Fig. 1. Healthy individuals were randomly assigned to the control group. Patients with periapical lesions on baseline diagnostic radiographs who completed treatment at the Inonu University Faculty of Dentistry, Department of Endodontics, and attended follow-up examinations were included in both groups. The inclusion and exclusion criteria for this study are shown in Table 1.

Following the review of the patients' digital records, the case group comprised 13 teeth from 11 patients. The control group consisted of 28 teeth from healthy individuals. Following the establishment of the case group, the control group was constituted by considering the mean age of the patients in the case group and the fact that all the patients were female. Accordingly, all volunteers included in the study were female. The mean age and clinical characteristics of the included patients are presented in Table 2.

The periapical status of the teeth was assessed using the Periapical Index (PAI) scoring system, which Ørstavik et al. developed in 1986 in terms of accuracy, reliability, reproducibility, and discriminatory capacity of periapical disease (25). The PAI scores of the initial and final periapical lesions were recorded and compared to assess the healing. Moreover, endodontic treatment outcomes were categorized according to the American Association of Endodontists (AAE) recommendations, based on clinical and radiographic findings obtained during follow-up visits (26) (Table 3). A graphical illustration of this study is shown in Figure 2.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA).

Fisher's exact test was used to compare the healing outcomes between the groups. The Wilcoxon signed-rank test was used to evaluate within-group healing, based on PAI scores.

The statistical tests used for the analysis are presented. The abbreviation PAI refers to the Periapical Index Score, which represents the scoring system used in the study.

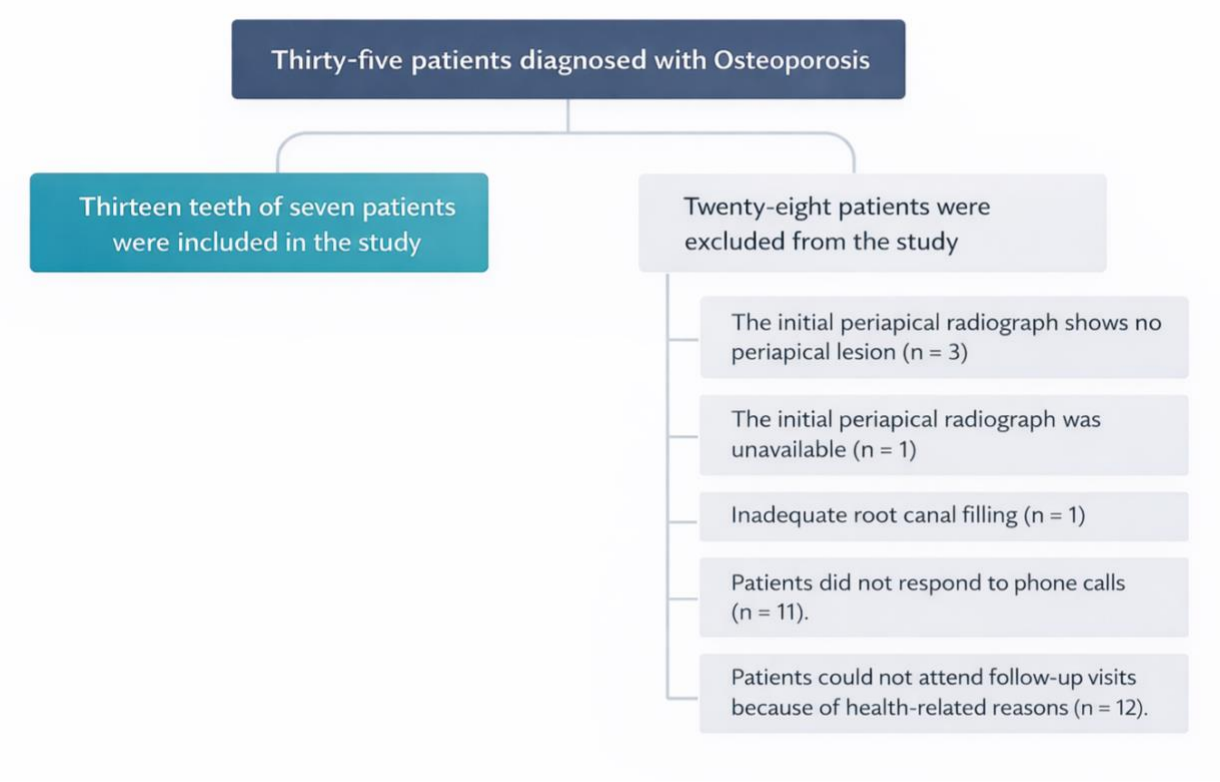

Figure 1. Study design.

Table 1. Inclusion and exclusion criteria for the study.

Inclusion criteria	Osteoporosis without any other systemic disease (case group); three patients with a history of breast cancer were included.
	Patients without any systemic disease (control group).
	Apical periodontitis in any tooth (case and control groups). Presence of periapical lesions on initial periapical radiographs (PAI ≥ 3).
	A follow-up period of at least 6 months.
Exclusion criteria	Absence of periapical lesions on initial periapical radiographs (PAI< 2).

Table 2. Demographic characteristics of the patients.

	Mean Age (min/max year)	Tooth type			Treatment type		Mean follow-up time (min/max month)
		Anterior	Premolar	Molar	Primary RCT	Retreatment	
Case Group	50 (45/71)	7	4	2	7	6	20.53 (7/68)
Control Group	50.31 (43/66)	14	9	5	22	6	27.67 (10/41)

Table 3. Classification of the PAI scoring system and American Association of Endodontists definitions for assessing the outcomes of root canal therapy.	
*This classification is based on the PAI.	
Score 1	Normal periapical tissues
Score 2	Minor structural changes in bone
Score 3	Changes in bone structure accompanied by some degree of mineral loss
Score 4	Periodontitis is characterized by a distinct and well-defined periapical radiolucency
Score 5	Severe periodontitis with exacerbating features
*American Association of Endodontists recommendations for root canal therapy outcomes.	
Healed	Functional, asymptomatic teeth with no or minimal radiographic periradicular (apical) pathosis (radiolucency).
Nonhealed	Nonfunctional, symptomatic teeth with or without radiographic periradicular (apical) pathosis (radiolucency).
Healing	Teeth with periradicular (apical) pathosis (radiolucency), which are asymptomatic and functional, or teeth with or without radiographic periradicular (apical) pathosis (radiolucency), which are symptomatic, but whose intended function is not altered.
Functional	A treated tooth or root that is serving its intended purpose in the dentition.

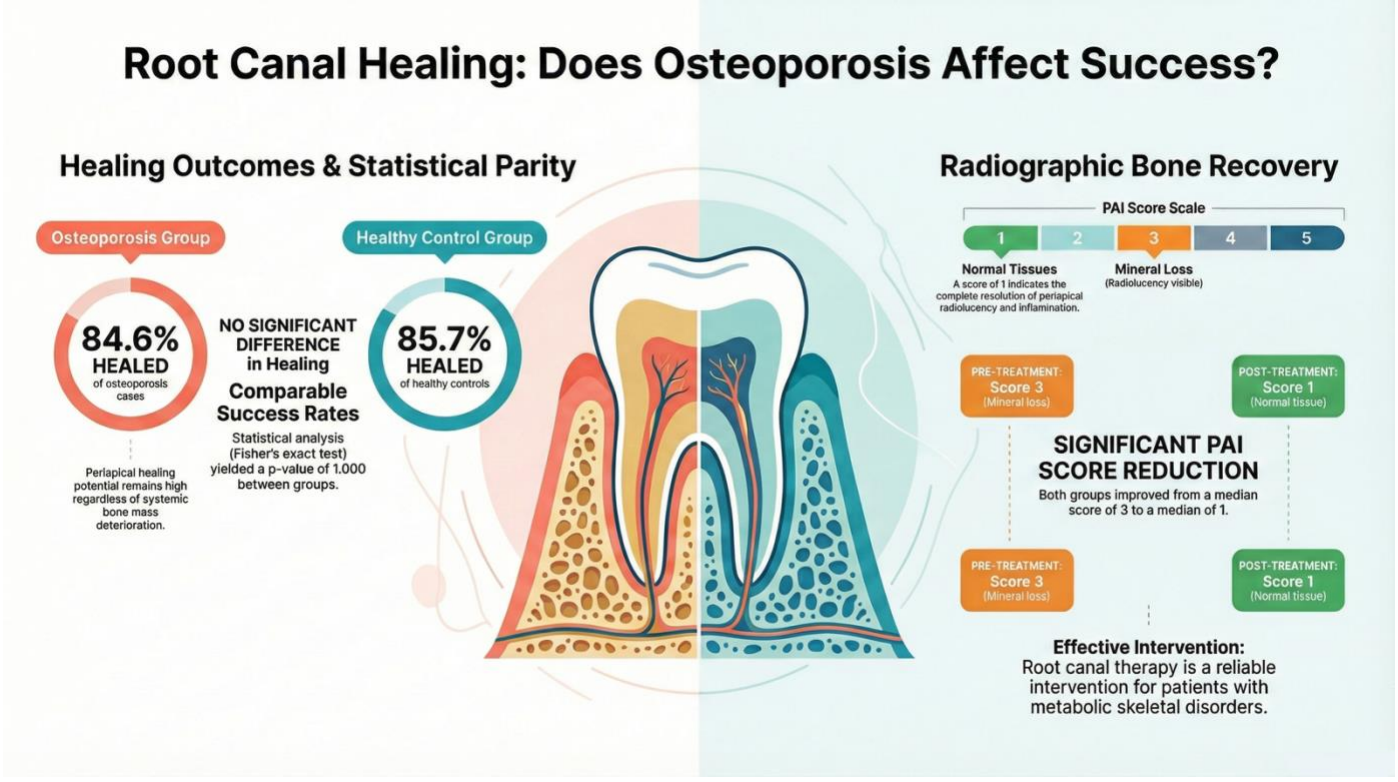

Figure 2. Graphical illustration of the study.

Results

Final periapical radiographs obtained at follow-up demonstrated radiographic evidence of healing in all treated teeth, characterized by a marked reduction or complete resolution of periapical radiolucency. Within-group comparisons revealed that PAI scores significantly improved following endodontic treatment in both the osteoporosis (case) and healthy (control) groups. Specifically, baseline and follow-up PAI scores differed statistically significant in the case group ($p = 0.002$) as well as in the control group ($p < 0.001$), indicating a significant radiographic healing response in both cohorts (Table 4).

Intergroup analyses showed that the two groups were comparable with respect to both baseline and follow-up PAI scores. No statistically significant difference was detected between the osteoporosis and control groups in terms of pre-treatment ($p = 0.947$) or post-treatment PAI scores ($p = 0.804$) (Figs. 2 and 3; Table 4). These findings suggest that radiographic healing outcomes after root canal treatment were

similar in patients with osteoporosis and systemically healthy individuals.

According to the American Association of Endodontists (AAE) outcome definitions, in the osteoporosis group, two teeth were categorized as healing and 11 teeth as healed. In the control group, four teeth were classified as healing and 24 teeth as healed. Comparison of these outcome distributions revealed no statistically significant difference between the groups (p = 1.000), indicating comparable endodontic treatment outcomes based on the AAE clinical and radiographic criteria (Table 5).

Table 4. Results of the statistical analysis of pre- and post-treatment PAI scores within and between groups.

Group	N	PAI (Before Treatment) Median (min-max)	PAI (After Treatment) Median (min-max)	p (before/after)
Case Group (13)	13	3 (2-4)	1 (1-3)	0.002
Control Group (28)	28	3 (2-3)	1 (1-3)	<0.001
p (case/control)		0.947	0.804	

Figure 2. Periapical radiographs of tooth #37 in an osteoporotic patient. **(A)** Preoperative, **(B)** postoperative, and **(C)** seven-month follow-up radiographs.

Figure 3. Periapical radiographs of tooth #22 in a healthy patient. **(A)** Preoperative, **(B)** postoperative, and **(C)** twenty-two-month follow-up radiographs.

Table 5. Statistical analysis of endodontic treatment outcomes according to the clinical and radiographic criteria of the AAE.

Group (N)	American Association of Endodontics		Total (n, %)
	Healing (n, %)	Healed (n, %)	
Case Group (13)	2, 15.4%	11, 84.6%	28, 100.0%
Control Group (28)	4, 14.3%	24, 85.7%	13, 100.0%
Total (n, %)	6, 14.6%	35, 85.4%	41, 100.0%
p		1.000	

Discussion

This retrospective study investigated whether periapical lesions in patients diagnosed with osteoporosis demonstrate a healing response after root canal treatment comparable to that observed in systemically healthy individuals. The main finding of this study was that periapical healing, as assessed using PAI scores and clinical follow-up data, did not differ significantly between osteoporotic patients and healthy individuals. Although both groups exhibited significant improvement from baseline to follow-up, intergroup comparisons did not reveal a statistically significant difference. These findings suggest that osteoporosis, at least in the clinical context represented by our sample, may not compromise the healing potential of periapical tissues following endodontic therapy.

The available evidence regarding the relationship between apical periodontitis and osteoporosis remains limited. In a study assessing the prevalence of osteoporosis in postmenopausal women, the authors reported a higher frequency of periapical lesions among osteoporotic patients (24). López-López J. et al. observed only a minimally significant association between the presence of periapical radiolucency and low bone mineral density (27). However, in the present study, the patient data were not adequate to evaluate this prevalence. Therefore, future multicenter studies with larger sample sizes may contribute to obtaining more reliable data on this topic.

In addition, several studies have investigated implant therapy in patients with osteoporosis. One clinical study reported that implants placed in patients with systemic osteoporosis did not show higher failure rates compared with implants placed in individuals without osteoporosis, and this finding is consistent with our findings (28). Moreover, review studies evaluating dental implant survival have suggested that implant therapy represents a viable treatment option for the rehabilitation of osteoporotic patients, with no clear evidence indicating increased implant failure in individuals with systemic osteoporosis (23, 29, 30).

Furthermore, findings of a study suggest that osteoporosis has a detrimental effect on alveolar socket healing after tooth extraction (31).

In a study investigating the relationship between endodontics and osteoporosis while considering age and sex, the authors suggested that periapical lesions in osteoporotic patients may enlarge and become more easily detectable due to lower bone density and an enhanced inflammatory response (32).

Since the findings of this study focused solely on periapical healing, no data was available regarding the risk of developing apical periodontitis in patients with osteoporosis. According to a systematic review and a meta-analyses report there is an increased prevalence of apical periodontitis in patients with osteoporosis (33, 34). Additionally, an umbrella review suggested a positive association between osteoporosis and apical periodontitis despite methodological limitations of the investigated studies (35). However, these results are contradictory to the findings of cohort and retrospective studies that found no direct relationship between osteoporosis and the occurrence of apical periodontitis in patients treated for osteoporosis (36, 37).

When the relationship between periodontal diseases and osteoporosis was evaluated, skeletal bone mineral density was found to be associated with interproximal alveolar bone loss and clinical attachment loss, osteoporosis was shown to have a direct effect on the progression rate of periodontal tissue destruction, and the prevalence and severity of periodontitis were demonstrated to be higher in osteoporotic patients compared to non-osteoporotic individuals (38-40).

Conclusion

Despite these limitations, our findings provide preliminary clinical evidence that patients with osteoporosis can achieve satisfactory periapical healing after root canal treatment. From a practical standpoint, the observed healing outcomes may reassure clinicians that conventional endodontic therapy remains an appropriate and effective intervention in this patient population. Future prospective multicenter studies with larger cohorts and standardized follow-up protocols are warranted to confirm these results.

Disclosures

Ethical Approval: Ethics committee approval was received for this study from the İnonu University Health Sciences Research Ethics Committee, in accordance with the World Medical Association Declaration of Helsinki, with the approval number: 2019/01-10.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – E.B.T.; Design – E.B.T., L.A.; Supervision – E.B.T.; Materials – E.B.T., Ö.T.; Data collection &/or processing – Ö.T.; Analysis and/or interpretation – E.B.T., Y.T.; Literature search – Ö.T., Y.T.; Writing – E.B.T.; Critical review – E.B.T., L.A.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: This research has not received external funding.

References

1. Teixeira-Salum TB, Rodrigues DBR, Gervásio AM, et al. Distinct Th1, Th2 and Treg cytokines balance in chronic periapical granulomas and radicular cysts. J Oral Pathol Med. 2010;39(3):250-256. https://doi.org/10.1111/j.1600-0714.2009.00863.x
2. Figdor D. Apical periodontitis: a very prevalent problem. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002;94(6):651-652. https://doi.org/10.1067/moe.2002.130322
3. Marton IJ, Kiss C. Overlapping protective and destructive regulatory pathways in apical periodontitis. J Endod. 2014;40(2):155-163. https://doi.org/10.1016/j.joen.2013.10.036
4. Cotti E, Schirru E, Acquas E, et al. An overview on biologic medications and their possible role in apical periodontitis. J Endod. 2014;40(12):1902-1911. https://doi.org/10.1016/j.joen.2014.08.013
5. Metzger Z, Huber R, Slavescu D, et al. Healing kinetics of periapical lesions enhanced by the apexum procedure: a clinical trial. J Endod. 2009;35(2):153-159. https://doi.org/10.1016/j.joen.2008.11.019
6. Galler KM, Weber M, Korkmaz Y, et al. Inflammatory response mechanisms of the dentine-pulp complex and the periapical tissues. Int J Mol Sci. 2021;22(3):1480. https://doi.org/10.3390/ijms22031480
7. Xiong H, Peng B, Wei L, et al. Effect of an estrogen-deficient state and alendronate therapy on bone loss resulting from experimental periapical lesions in rats. J Endod. 2007;33(11):1304-1308. https://doi.org/10.1016/j.joen.2007.07.011
8. Stashenko P, Teles R, D'Souza R. Periapical inflammatory responses and their modulation. Crit Rev Oral Biol Med. 1998;9(4):498-521. https://doi.org/10.1177/10454411980090040701
9. Viswanath B, Priyank H, Shivakumar S, et al. Periapical healing outcome following non-surgical endodontic intervention among diabetic patients: a systematic review conducted according to PRISMA guidelines and the Cochrane handbook for systematic reviews of interventions. Saudi Dent J. 2024;36(1):52-59. https://doi.org/10.1016/j.sdentj.2023.10.002
10. Holland R, Gomes JEF, Cintra LTA, et al. Factors affecting the periapical healing process of endodontically treated teeth. J Appl Oral Sci. 2017;25(5):465-476. https://doi.org/10.1590/1678-7757-2016-0464
11. Loi F, Córdova LA, Pajarinen J, et al. Inflammation, fracture and bone repair. Bone. 2016;86:119-130. https://doi.org/10.1016/j.bone.2016.02.020
12. Compston JE, McClung MR, Leslie WD. Osteoporosis. Lancet. 2019;393(10169):364-376. https://doi.org/10.1016/S0140-6736(18)32112-3
13. Ye C, Ebeling PR, Kline G. Osteoporosis. Lancet. 2025;406(10514):1952-1952. https://doi.org/10.1016/S0140-6736(25)01385-6
14. Zhuang R, Hou W, Zhang T, et al. Association between dietary vitamin E and osteoporosis in older adults in the United States. Front Endocrinol (Lausanne). 2024;15:1410581. https://doi.org/10.3389/fendo.2024.1410581
15. Medeiros F, Kudo G, Leme B, et al. Dental implants in patients with osteoporosis: a systematic review with meta-analysis. International Journal of Oral and Maxillofacial Surgery. 2018;47(4):480-491. https://doi.org/10.1016/j.ijom.2017.05.021
16. Mulligan R, Sobel S. Osteoporosis: diagnostic testing, interpretation, and correlations with oral health—implications for dentistry. Dental Clinics of North America. 2005;49(2):463-484. https://doi.org/10.1016/j.cden.2004.10.005
17. Temmerman A, Rasmusson L, Kübler A, Thor A, Quirynen M. An open, prospective, non-randomized, controlled, multicentre study to evaluate the clinical outcome of implant treatment in women over 60 years of age with osteoporosis/osteopenia: 1-year results. Clinical Oral Implants Res. 2016;28(1):95-102. https://doi.org/10.1111/clr.12766
18. Becker W, Hujoel P, Becker B, & Willingham H Osteoporosis and implant failure: an exploratory case-control study. Journal of Periodontology. 2000;71(4):625-631. https://doi.org/10.1902/jop.2000.71.4.625
19. Siebert T, Jurkovič R, Statelová D, & Strecha J Immediate implant placement in a patient with osteoporosis undergoing bisphosphonate therapy: 1-year preliminary prospective study. Journal of Oral Implantology. 2015;41(S1):360-365. https://doi.org/10.1563/aaid-joi-d-13-00063
20. Al-Sabbagh M, Robinson F, Romanos G, & Thomas M Osteoporosis and bisphosphonate-related osteonecrosis in a dental school implant patient population. Implant Dentistry. 2015;24(3):328-32. https://doi.org/10.1097/id.0000000000000234
21. Türkiye Osteoporoz Derneği. Türkiye Kalça Kırığı İnsidansı ve Osteoporoz Prevalansı. Accessed January 17, 2026. https://osteoporoz.org.tr/osteoporozhakkinda/Osteoporoz-Hakk%C4%B1nda.html
22. Lerner UH. Bone remodeling in post-menopausal osteoporosis. J Dent Res. 2006;85(7):584-595. https://doi.org/10.1177/154405910608500703
23. Lemos CAA, de Oliveira AS, Fae DS, et al. Do dental implants placed in patients with osteoporosis have higher risks of failure and marginal bone loss compared to those in healthy patients? A systematic review with meta-analysis. Clin Oral Investig. 2023;27(6):2483-2493. https://doi.org/10.1007/s00784-023-05005-2
24. Katz J, Rotstein I. Prevalence of periapical lesions in patients with osteoporosis. J Endod. 2021;47(2):234-238. https://doi.org/10.1016/j.joen.2020.10.019

25. Orstavik D, Kerekes K, Eriksen HM. The periapical index: a scoring system for radiographic assessment of apical periodontitis. Endod Dent Traumatol. 1986;2(1):20-34. https://doi.org/10.1111/j.1600-9657.1986.tb00119.x
26. American Association of Endodontists. Glossary of Endodontic Terms. Accessed January 17, 2026. https://www.aae.org/specialty/clinical-resources/glossary-endodontic-terms/
27. López-López J, Castellanos-Cosano L, Estrugo-Devesa A, et al. Radiolucent periapical lesions and bone mineral density in post-menopausal women. Gerodontology. 2015;32(3):195-201. https://doi.org/10.1111/ger.12076
28. de Medeiros F, Kudo GAH, Leme BG, et al. Dental implants in patients with osteoporosis: a systematic review with meta-analysis. Int J Oral Maxillofac Surg. 2018;47(4):480-491. https://doi.org/10.1016/j.ijom.2017.05.021
29. Kim SY, Lee YJ, Kang YJ, et al. Impact of osteoporosis on dental implant survival, failure, and marginal bone loss: a systematic review and meta-analysis. J Clin Med. 2025;14(19):6719. https://doi.org/10.3390/jcm14196719
30. Chen H, Liu N, Xu X, et al. Smoking, radiotherapy, diabetes and osteoporosis as risk factors for dental implant failure: a meta-analysis. PLoS One. 2013;8(8):e71955. https://doi.org/10.1371/journal.pone.0071955
31. So BB, Silveira FM, Llantada GS, Jardim LC, Calcagnotto T, Martins MAT, et al. Effects of osteoporosis on alveolar bone repair after tooth extraction: A systematic review of preclinical studies. Arch Oral Biol 2021;125:105054. https://doi.org/10.1016/j.archoralbio.2021.105054
32. Goker Kamali S, Turkaydin D. Endodontic and periapical status of patients with osteoporosis: A cross-sectional study with age- and sex-matched controls. J Am Dent Assoc 2024;155(12):1022-1030. https://doi.org/10.1016/j.adaj.2024.09.010
33. Pestana de Vasconcelos N, Martins IS, Afonso AS, Braga AC, Pina-Vaz I. Osteoporosis and Apical Periodontitis Prevalence: A Systematic Review. Dent J (Basel) 2024;12(8). https://doi.org/10.3390/dj12080272
34. Areal-Quecuty V, Cantiga-Silva C, Simon-Soro A, Cabanillas-Balsera D, Martin-Gonzalez J, Sauco-Marquez JJ, et al. Apical periodontitis in osteoporotic postmenopausal women: Systematic review and meta-analysis. Med Oral Patol Oral Cir Bucal 2024;29(5):e711-e718. https://doi.org/10.4317/medoral.26697
35. Pinto KP, Serrao G, Alves Ferreira CM, Sassone LM, Fidalgo T, Silva E. Association between Apical Periodontitis and Chronic Diseases: An Umbrella Review. Iran Endod J 2023;18(3):134-144.
36. Grun P, Meier M, Dittrich J, Gjergjindreaj A, Strobele D, Pfaffeneder-Mantai F, et al. Assessment of the occurrence of apical periodontitis and endodontically treated/non-treated teeth in a Lower Austrian patient population treated for osteoporosis: a cohort study. Ann Med Surg (Lond) 2024;86(9):5049-5057. https://doi.org/10.1097/MS9.0000000000002443
37. Cadoni E, Ideo F, Marongiu G, Mezzena S, Frigau L, Mela Q, et al. Periapical status in patients affected by osteoporosis: A retrospective clinical study. Clin Exp Dent Res 2022;8(5):1068-1075. https://doi.org/10.1002/cre2.604
38. Manjunath SH, Rakhewar P, Nahar P, Tambe V, Gabhane M, Kharde A. Evaluation of the Prevalence and Severity of Periodontal Diseases between Osteoporotic and Nonosteoporotic Subjects: A Cross-sectional Comparative Study. J Contemp Dent Pract 2019;20(10):1223-1228. https://doi.org/10.5005/jp-journals-10024-2717
39. Ayed MS, Shafiq SS, Diab HM, Alahmari AD, Divakar DD. Assessing periapical dental radiographs as a screening parameter for early indications of osteoporosis in postmenopausal periodontal patients and root surface evaluation using spectrochemical analysis. Saudi Med J 2018;39(7):719-724. https://doi.org/10.15537/smj.2018.7.22453
40. Sultan N, Rao J. Association between periodontal disease and bone mineral density in postmenopausal women: a cross sectional study. Med Oral Patol Oral Cir Bucal 2011;16(3):e440-447. https://doi.org/10.4317/medoral.16.e440