Original paper

Endodontic status of patients with coronary atherosclerosis: A cross-sectional study

Paola Andrea Escobar-Villegas[1,2,A–F], Ana Isabel Realpe-Camelo[2,B–F], Diana Andrea Arana-Salas[2,C–F], Jorge Guillermo Velásquez[3,4,D–F], Manuel Paulo[3,4,D–F], Carlos Humberto Martínez-Cajas[2,B–F], Sandra Amaya-Sanchez[2,A–F], Juan Esteban Gómez-Mesa[3,5,A–F]

[1] The University Colleges of Colombia (UNICOC), Cali, Colombia
[2] School of Dentistry, University of Valle, Cali, Colombia
[3] Department of Cardiology, Fundación Valle del Lili, Cali, Colombia
[4] Department of Internal Medicine, Fundación Valle del Lili, Cali, Colombia
[5] Department of Health Sciences, Icesi University, Cali, Colombia

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Dental and Medical Problems, ISSN 1644-387X (print), ISSN 2300-9020 (online)   *Dent Med Probl*. 2026;63(4):885–891

Address for correspondence
Juan Esteban Gómez-Mesa
E-mail: juan.gomez.me@fvl.org.co

Funding sources
None declared

Conflict of interest
None declared

Acknowledgements
This study was presented at the VII Endodontic Research Meeting organized by the Colombian Association of Endodontics with support from the National University of Colombia Faculty of Dentistry's postgraduate program in endodontics.

Received on February 20, 2025
Reviewed on April 22, 2025
Accepted on May 22, 2025

Published online on August 28, 2026

Cite as
Escobar-Villegas PA, Realpe-Camelo AI, Arana-Salas DA, et al. Endodontic status of patients with coronary atherosclerosis: A cross-sectional study. *Dent Med Probl.* 2026;63(4):885–891. doi:10.17219/dmp/205472

DOI
10.17219/dmp/205472

Abstract

Background. There are no studies in the Colombian population assessing the prevalence and severity of apical lesions (ALs), or the relationship between the frequency and quality of endodontic treatment (ET) obturation and the presence of ALs in patients with coronary atherosclerosis (CA).

Objectives. The present study aimed to estimate the frequency of ALs and ET in Colombian patients with CA, and to identify a possible association between the frequency and severity of ALs and CA.

Material and methods. The study had a cross-sectional design. We included patients with the evidence of CA diagnosed by coronary angiography. The main outcome variables were the number of compromised coronary arteries and their degree of obstruction, as well as ET, including ALs and previously treated teeth (PTT). The periapical index (PAI) was assessed using periapical radiographs.

Results. A total of 1,394 teeth from 69 patients were evaluated ($\delta = 20.2$ teeth/patient). The frequency of ALs and ET was 5.7% and 10.1%, respectively, considering all teeth evaluated, with a greater presence in the maxilla (50.6% and 51.4%, respectively). Apical lesions were most frequently observed in premolars and molars (35.4%), whereas ET was more frequent in molars (38.6%). Among teeth with ALs, PAI 3 was the most frequent score. Apical lesions were present in 36.6% of endodontically treated teeth; 72.9% of these teeth had inadequate obturation, of which 40 (39.2%) had ALs ($p = 0.021$).

Conclusions. In patients with CA, a high incidence of ALs and ET was observed, with no evidence of an association between the frequency of ALs, the severity of coronary vessel occlusion, and the number of coronary arteries affected. More ALs were observed in teeth with inadequate ET. However, as we did not have a control group for comparison, these findings should be interpreted with caution.

Keywords: atherosclerosis, coronary artery disease, coronary disease, periapical periodontitis, root canal obturation

Highlights

- This study reveals high rates of apical lesions (ALs) and endodontic treatment (ET) in patients with coronary atherosclerosis (CA), highlighting potential oral health implications in cardiovascular care.
- A greater presence of ALs was observed in males, which was partially related to a higher prevalence of CA in these patients.
- Teeth with inadequate ET had more ALs.

Introduction

Coronary atherosclerosis (CA) is the underlying cause of several cardiovascular diseases (CVDs). It is characterized by the narrowing of the arterial lumen due to the accumulation of fatty deposits and the loss of elasticity of the arterial walls, resulting in vessel stenosis and reduced blood flow.[1,2] Coronary atherosclerosis has been defined as a lesion of the intimal layer of blood vessels, comprising a fibrous cap and an atheromatous core. The plaque is composed of smooth muscle cells, the extracellular matrix (ECM), inflammatory cells, calcifications, lipids, and necrotic debris.[3] Cardiovascular diseases are among the leading causes of disability and mortality worldwide.[4] According to Joseph et al., in 2015, deaths attributable to CVDs accounted for approx. ⅓ of all deaths globally.[5] In Colombia, CVDs are a leading cause of death. According to the Pan American Health Organization (PAHO), in 2021, 190.2 deaths from CVDs were reported in Colombia per 100,000 inhabitants.[6]

Apical periodontitis (AP) is an acute or chronic inflammatory lesion around the apex of a tooth caused by a polymicrobial infection of the root canal system,[7,8] characterized by periapical bone resorption, referred to as an apical lesion (AL).[9] This condition is one of the persistent inflammatory disorders of the oral cavity and may contribute to systemic inflammation.[10,11] It has been associated with platelet aggregation and hypercoagulability.[8,12] The etiological factors of AP include various forms of dental pulp damage, such as caries, trauma, iatrogenic injury, and the failure of endodontic treatment (ET).[13] Endodontic treatment can prevent AP or restore dental health by eliminating intraradicular infection,[14] promoting bone repair[15] and maintaining proper tooth function.[16] Adequate root canal filling plays an important role in successful ET by preventing bacterial reinfection through the reduction of coronal leakage and, consequently, halting disease progression.[17] The impact of ET quality has been evaluated based on radiographic criteria, and root canal fillings can be classified as adequate or inadequate.[18]

The reported prevalence of AP and ET varies worldwide.[19–21] However, there are no studies in the Colombian population evaluating the frequency and severity of ALs, their relationship with the frequency and quality of ET obturation, or their association with CA. Therefore, this study aimed to estimate the frequency of ALs and ET in Colombian patients with CA, and to identify a possible association between the frequency and severity of ALs and CA.

Material and methods

This was an observational, descriptive, cross-sectional study that included patients with the angiographic evidence of CA, recruited between 2017 and 2020 at the Fundación Valle del Lili, Cali, Colombia.

The study was approved in November 2017 by the Biomedical Research Ethics Committee of the Fundación Valle del Lili (approval No. 730-217). All patients provided written informed consent prior to enrollment in the study. The study was conducted in accordance with ethical considerations and the Declaration of Helsinki.

Coronary angiography was performed using the Innova 3100 IQ system (GE HealthCare, Waukesha, USA). The procedure began with arterial puncture (femoral or radial), followed by the insertion of a specialized catheter into the left chambers of the heart. A contrast medium was then injected through the catheter, allowing the visualization of the coronary artery lumen with the use of specialized imaging techniques, and enabling the presence or absence of atherosclerosis to be determined.

Convenience sampling was used to recruit patients during the study period. We included patients over 18 years of age who had at least one tooth in the mouth, a confirmed diagnosis of CA, and who agreed to participate in the study and signed the informed consent form. Further details of the study population are presented in Fig. 1. Patients with contraindications to X-ray exposure, pregnant women, and patients who had received dental treatment within the previous 3 months were excluded.

Sociodemographic data and medical information related to the cardiovascular condition were collected, including the number of compromised coronary arteries and their degree of occlusion, classified as non-significant (≤50% occlusion), significant (51–70%), severe (71–90%), or critical (>90%). Information regarding ET was also collected, including the presence of ALs and previously treated teeth (PTT). The periapical index (PAI) was assessed using periapical radiographs[22]; this index allows the evaluation of the

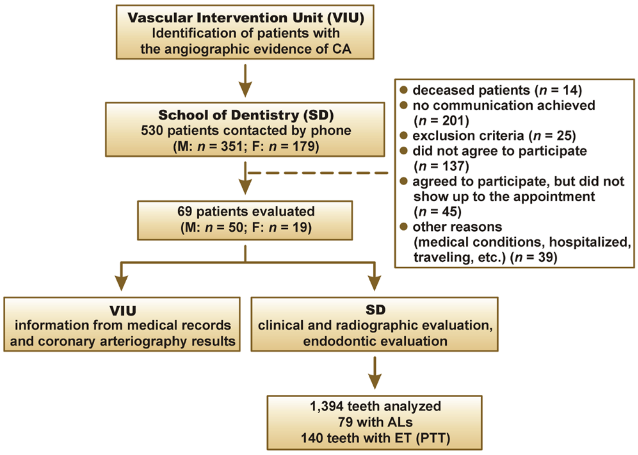

Fig. 1. Study design – selection of patients according to the inclusion and exclusion criteria

CA – coronary atherosclerosis; M – male; F – female; Al – apical lesion; ET – endodontic treatment; PTT – previously treated teeth.

condition of the periradicular tissues. For this study, PAI scores of 1 and 2 were considered indicative of periapical health, whereas PAI scores ≥3 were considered indicative of AP.[23–25] According to the American Association of Endodontists (AAE), teeth that had undergone ET were defined as PTT.[26] The quality of root canal obturation was classified as adequate or inadequate.[18]

Statistical analysis

For statistical analysis, absolute and relative frequencies were calculated for categorical variables. The measures of central tendency and dispersion were calculated for clinical, radiographic, and clinical history variables. Associations between the categorical variables related to PAI and endodontic diagnoses were assessed using the χ^2 test. The Shapiro–Wilk and Levene tests were used to assess the distribution and homogeneity of variance, respectively, when comparing the mean numbers of teeth according to endodontic diagnoses and PAI. The severity of coronary artery occlusion in patients with CA was compared using the Kruskal–Wallis test. The confidence level was set at 95%, and statistical significance was defined as $p < 0.05$.

Results

A total of 530 patients with CA were identified through coronary angiography. Of these, 114 met the inclusion criteria, 69 agreed to participate and attended the scheduled assessment, and 1,394 teeth were evaluated (δ = 20.2 teeth/patient) (Fig. 1).

Among the 69 included patients, the mean age was 65.7 ±8.6 years, and 50 (72.5%) were men. At the patient level, ALs and PTTs were present in 35 (50.7%) and 41 (59.4%) patients, respectively (Table 1). At the tooth level, ALs and PTT were observed in 79 (5.7%) and 140 (10.1%) teeth, respectively (Fig. 2A), with a greater proportion located in the

Table 1. Presence of apical lesions (ALs) and previously trated teeth (PTT) according to sex

Presence of ALs and PTT		M	F	Total
ALs	yes	25 (71.4)	10 (28.6)	35 (50.7)
	no	25 (73.5)	9 (26.5)	34 (49.3)
PTT	yes	29 (70.7)	12 (29.3)	41 (59.4)
	no	21 (75.0)	7 (25.0)	28 (40.6)
Total		50 (72.5)	19 (27.5)	69 (100.0)

Data presented as number (percentage) (n (%)). $p > 0.05$.

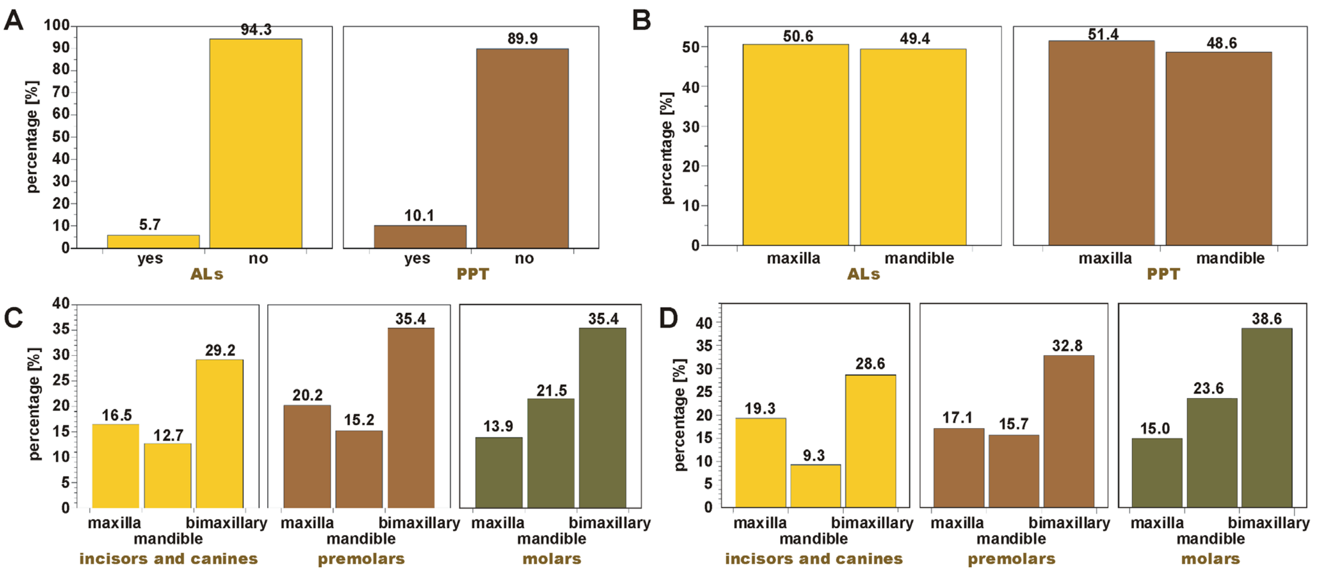

Fig. 2. Presence of apical lesions (ALs) and previously treated teeth (PTT)

A – ALs and PTT according to the total number of teeth evaluated; B – ALs and PTT according to the type of jaw; C – ALs in both jaws according to the type of tooth; D – PTT in both jaws according to the type of tooth.

maxilla, accounting for 40 (50.6%) ALs and 72 (51.4%) PTT (Fig. 2B). In both jaws, ALs were most frequently observed in premolars and molars, accounting for 28 (35.4%) cases (Fig. 2C), whereas PTT were more frequently observed in molars, accounting for 54 (38.6%) cases (Fig. 2D).

Among patients with ALs, 10 (28.6%) had at least one coronary artery with a significant atherosclerotic lesion, and the same proportion had at least one artery with a severe lesion. Additionally, 8 (22.9%) patients had at least one artery with a non-significant lesion, and the same proportion had at least one artery with a critical lesion (Supplementary Table 1, available on request from the corresponding author). Severe and critical atherosclerotic lesions were more frequently observed (in 34 and 25 patients, respectively), with PAI 3 being the most frequent score in both groups (0.68 ±1.32 and 0.80 ±1.04 teeth, respectively) ($p > 0.05$) (Supplementary Table 2).

Among teeth with ALs, PAI 3 was the most frequent score, with no significant difference between endodontic diagnoses with regard to PAI (Table 2). Of the 140 PTT, 47 (36.6%) presented with ALs. Inadequate obturation was observed in 102 (72.9%) PTT, of which 40 (39.2%) had ALs ($p = 0.021$). Most patients did not recall the timing of ET or the type of operator who performed ET (Table 3).

Discussion

The prevalence of AP in patients with CA reported in the literature ranges from 50.8% to 85.3%,[23,27] similar to the findings of this study. An AP frequency of 39.2% in males and 44.2% in females has been reported in previous studies.[28] In this study, a greater presence of ALs was observed in males, which may be partially related to the higher prevalence of CA among male patients.[29] The presence of ALs in teeth was 5.7%, with asymptomatic AP being the most prevalent periapical diagnosis (5.5%). These results are similar to those reported by Tibúrcio-Machado et al., who found a global prevalence of AP of 52% in patients without systemic compromise and 5% in teeth.[30] Likewise, de Oliveira et al. reported a prevalence of AP of 42.6% in patients with CA and 40.1% in endodontically compromised teeth,[28] which is similar to the findings of this study. The prevalence of ET reported in previous studies ranges from 41.0% to 60.8% in patients, and from 2% to 9% in teeth,[31,32] which is also similar to our findings. Moreover, the prevalence of AP in teeth with ET found in this study is consistent with the previously reported global prevalence of 41%.[33]

De Oliveira et al. reported a greater presence of AP in the maxilla, upper incisors and lower premolars (40.3%,

Table 2. Endodontic diagnoses according to the periapical index (PAI)

Endodontic diagnoses		ALs			Total	*p*-value
		PAI 3	PAI 4	PAI 5		
Pulp diagnoses	pulp necrosis	16 (50.0)	12 (37.5)	4 (12.5)	32 (100.0)	0.296
	PTT	32 (68.1)	11 (23.4)	4 (8.5)	47 (100.0)	
Periapical diagnoses	asymptomatic AP	48 (62.3)	22 (28.6)	7 (9.1)	77 (100.0)	0.092
	chronic apical abscess	0 (0.0)	1 (50.0)	1 (50.0)	2 (100.0)	

Data presented as *n* (%).
AP – apical periodontitis.

Table 3. Distribution of endodontic variables according to the presence of apical lesions (ALs)

Variables		Presence of ALs		Total	*p*-value
		yes	no		
PTT		47 (33.6)	93 (66.4)	140 (100.0)	–
Radiographic quality of the obturation	adequate	7 (18.4)	31 (81.6)	38 (100.0)	0.021*
	inadequate	40 (39.2)	62 (60.8)	102 (100.0)	
Timing of ET	do not remember	34 (35.1)	63 (64.9)	97 (100.0)	0.316
	1 year	1 (50.0)	1 (50.0)	2 (100.0)	
	1–2 years	6 (46.2)	7 (53.8)	13 (100.0)	
	3–5 years	0 (0.0)	8 (100.0)	8 (100.0)	
	5 years	7 (35.0)	13 (65.0)	20 (100.0)	
Operator	do not remember	39 (37.5)	65 (62.5)	104 (100.0)	0.242
	general dentist	6 (21.4)	22 (78.6)	28 (100.0)	
	endodontic specialist	2 (25.0)	6 (75.0)	8 (100.0)	

Data presented as *n* (%). * statistically significant.

52.8% and 46.2%, respectively).[28] In the present study, the maxilla, upper premolars and lower molars had a higher frequency of ALs. Previous studies have reported a higher prevalence of ET in the maxilla,[34–40] and a high prevalence of ET in molars.[34,38] These findings are consistent with those of the present study.

Apical periodontitis and periodontal disease differ in terms of their etiology and pathogenesis; however, they share similar characteristics. Both are chronic oral infectious diseases, share a common Gram-negative microbiota and result in increased levels of inflammatory mediators.[28,39] A potential relationship between periodontal disease and CVDs has been reported previously[40–42]; therefore, it has been hypothesized that AP could also impact patients with cardiovascular compromise due to its close relationship with periodontal disease.[28] Several studies have demonstrated an increased risk associated with AP in patients with CVDs and CA, suggesting that an increase in the number of teeth with AP is associated with a higher risk of CVDs.[23,24,27,28,,43–46]

There are no reports in the literature on the relationship between the frequency and severity of ALs, the number of coronary vessels affected, and the severity of their occlusion. Virtanen et al. conducted a cross-sectional study in which medical information was collected from randomly selected subjects, who were classified as patients with or without AP, and found a greater tendency and severity of ALs in patients with CVDs.[47] They showed that AP was significantly associated with CVDs and suggested that the presence of AP in subjects who also regularly had periodontal disease might indicate a higher oral inflammatory load.[47] In contrast to the findings of Virtanen et al.,[47] but in line with those reported by Frisk et al.[48] and Frisk,[49] we found no association between the severity of ALs and CA. This may be explained by the fact that both AP and CVDs can occur independently without directly affecting each other.[10] It is important to highlight that the quality of the current evidence is moderate to low, and a causal relationship between these two diseases could not be established.[50]

Regarding the quality of ET, no studies exclusively evaluating populations with CA were found. Kielbassa et al. reported a prevalence of adequate ET of 9.9%, while 50.3% of ET was considered inadequate.[37] Virtanen et al. found that, among the 60.8% of patients with ET analyzed, 38.3% were considered to have satisfactory ET, whereas 51.7% were considered to have unsatisfactory ET.[47] Moreno et al. reported that 66.7% of the teeth evaluated had inadequate ET; of these, 54.0% presented ALs.[35] These results are similar to our findings, in which a statistically significant association was found. Different studies have reported a significant association between the quality of ET and the status of the periapical tissues,[35–37,51] suggesting that inadequate ET may act as a risk factor for the development of ALs.[33,52] This may indicate that ET has a protective effect on the periapical tissues when performed adequately.

Various studies have evaluated the success rate of ET, which is characterized by the restoration of dental health (i.e., no evidence of AP), the prevention of AP, the continued retention of the tooth, and the restoration of its function. Alley et al. reported a higher success rate for ET performed by endodontists (98.1%) than by general dentists (89.7%) over a 5-year period.[53] Lazarski et al. found no differences in the ET success rates according to the type of operator, reporting an overall success rate of 94.4% over a period of 3.5 years.[54] Burry et al. analyzed the survival of teeth with ET, and found a decrease in the survival rates at 1, 5 and 10 years.[55] They did not observe differences between operators at 1 and 5 years; however, at 10 years, they found better survival of the molars treated by endodontists.[55] These results are not directly comparable with our study, since most patients did not remember the type of operator who performed ET. In addition, an unequal proportion of treatment performed by general dentists and endodontists was observed.

Limitations

Among the limitations of this study is the use of a convenience sampling method, which may introduce sampling bias and limit the generalizability of the results. In addition, we did not conduct a power analysis to determine the required sample size, which may have influenced the results obtained. Moreover, we acknowledge that the lack of a control group is a major limitation; therefore, we suggest that future studies include a matched control group to strengthen the conclusions drawn. Although the objective of this study was to determine whether there was an association between the frequency and severity of ALs and CA, the statistical approach used cannot be interpreted as a correlation or used to establish impact, as other factors that could influence the results were not included in the analysis (e.g., oral hygiene and mechanical stress). A larger sample size, a more balanced representation of men and women, and a wider age range would also be desirable to further validate our results. Finally, we suggest that future studies incorporate cone-beam computed tomography (CBCT), as it provides a more objective assessment of ALs.

Conclusions

A high frequency of ALs and ET was found in patients with CA. No relationship was found between the frequency of ALs, the severity of coronary occlusion, and the number of coronary arteries affected. A greater presence of AL was found in teeth with inadequate ET. Since most patients could not recall the timing of their ET or the type of operator who performed ET, an association between the presence of ALs, the timing of ET and the type of operator could not be determined. However, as this study did not include a control group for comparison with patients with CA, our results should be interpreted with caution.

Ethics approval and consent to participate

This study was approved by the Biomedical Research Ethics Committee of the Fundación Valle del Lili, Cali, Colombia (approval No. 730-217). All patients provided written informed consent prior to enrollment in the study. The study was conducted in accordance with ethical considerations and the Declaration of Helsinki.

Data availability

The datasets supporting the findings of the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Use of AI and AI-assisted technologies

Not applicable.

ORCID iDs

Paola Andrea Escobar-Villegas https://orcid.org/0000-0003-0703-0475
Ana Isabel Realpe-Camelo https://orcid.org/0000-0001-8598-2127
Diana Andrea Arana-Salas https://orcid.org/0000-0001-8462-2568
Jorge Guillermo Velásquez https://orcid.org/0009-0009-0501-2776
Manuel Paulo https://orcid.org/0000-0002-4995-4767
Carlos Humberto Martínez-Cajas https://orcid.org/0000-0002-4392-8453
Sandra Amaya-Sanchez https://orcid.org/0000-0002-9344-7930
Juan Esteban Gómez-Mesa https://orcid.org/0000-0002-6635-6224

References

1. Insull Jr. W. The pathology of atherosclerosis: Plaque development and plaque responses to medical treatment. *Am J Med*. 2009;122(Suppl 1):S3–S14. doi:10.1016/j.amjmed.2008.10.013
2. Herrington W, Lacey B, Sherliker P, Armitage J, Lewington S. Epidemiology of atherosclerosis and the potential to reduce the global burden of atherothrombotic disease. *Circ Res*. 2016;118(4):535–546. doi:10.1161/CIRCRESAHA.115.307611
3. Kumar V, Abbas AK, Aster JC. Heart. In: Kumar V, Abbas AK, Aster JC, eds. *Robbins Basic Pathology*. 10th ed. Amsterdam, The Netherlands: Elsevier; 2018:399–440.
4. Ye L, Cao L, Song W, Yang C, Tang Q, Yuan Z. Interaction between apical periodontitis and systemic disease (review). *Int J Mol Med*. 2023;52(1):60. doi:10.3892/ijmm.2023.5263
5. Joseph P, Leong D, McKee M, et al. Reducing the global burden of cardiovascular disease, part 1: The epidemiology and risk factors. *Circ Res*. 2017;121(6):677–694. doi:10.1161/CIRCRESAHA.117.308903
6. Pan American Health Organization (PAHO). Cardiovascular disease burden in the Region of the Americas, 2000–2021. ENLACE data portal. Washington, D.C.: PAHO; 2025. https://www.paho.org/en/enlace/cardiovascular-disease-burden. Accessed August 20, 2026.
7. Eriksen HM. Epidemiology of apical periodontitis. In: Ørstavik D, Pitt Ford TR, eds. *Essential Endodontology: Prevention and Treatment of Apical Periodontitis*. Oxford, UK: Blackwell Science Ltd.; 1998:179–191.
8. Caplan DJ, Chasen JB, Krall EA, et al. Lesions of endodontic origin and risk of coronary heart disease. *J Dent Res*. 2006;85(11):996–1000. doi:10.1177/154405910608501104
9. Karamifar K, Tondari A, Saghiri MA. Endodontic periapical lesion: An overview on the etiology, diagnosis and current treatment modalities. *Eur Endod J*. 2020;5(2):54–67. doi:10.14744/eej.2020.42714
10. Jiménez-Sánchez MC, Cabanillas-Balsera D, Areal-Quecuty V, Velasco-Ortega E, Martín-González J, Segura-Egea JJ. Cardiovascular diseases and apical periodontitis: Association not always implies causality. *Med Oral Patol Oral Cir Bucal*. 2020;25(5):e652–e659. doi:10.4317/medoral.23665
11. Gomes MS, Blattner TC, Sant'Ana Filho M, et al. Can apical periodontitis modify systemic levels of inflammatory markers? A systematic review and meta-analysis. *J Endod*. 2013;39(10):1205–1217. doi:10.1016/j.joen.2013.06.014
12. Cowan LT, Lakshminarayan K, Lutsey PL, Beck J, Offenbacher S, Pankow JS. Endodontic therapy and incident cardiovascular disease: The Atherosclerosis Risk in Communities (ARIC) study. *J Public Health Dent*. 2020;80(1):79–91. doi:10.1111/jphd.12353
13. El Merini H, Amarir H, Lamzawaq A, Hamza M. Periapical status and quality of root canal fillings in a Moroccan subpopulation. *Int J Dent*. 2017;2017:1068982. doi:10.1155/2017/1068982
14. Alghamdi F, Alsulaimani M. Regenerative endodontic treatment: A systematic review of successful clinical cases. *Dent Med Probl*. 2021;58(4):555–567. doi:10.17219/dmp/132181
15. Wu MK, Shemesh H, Wesselink PR. Limitations of previously published systematic reviews evaluating the outcome of endodontic treatment. *Int Endod J*. 2009;42(8):656–666. doi:10.1111/j.1365-2591.2009.01600.x
16. Marquis VL, Dao T, Farzaneh M, Abitbol S, Friedman S. Treatment outcome in endodontics: the Toronto Study. Phase III: Initial treatment. *J Endod*. 2006;32(4):299–306. doi:10.1016/j.joen.2005.10.050
17. Mittal N, Thangamuthu T, Gupta S, Gupta S, Aggarwal H, Kharat S. Comparative evaluation of resin-based sealers and bioceramic sealers for postoperative pain after endodontic treatment: A systematic review. *Dent Med Probl*. 2024;61(2):293–300. doi:10.17219/dmp/155885
18. Tronstad L, Asbjørnsen K, Døving L, Pedersen I, Eriksen HM. Influence of coronal restorations on the periapical health of endodontically treated teeth. *Endod Dent Traumatol*. 2000;16(5):218–221. doi:10.1034/j.1600-9657.2000.016005218.x
19. Segura-Egea JJ, Jiménez-Pinzón A, Poyato-Ferrera M, Velasco-Ortega E, Ríos-Santos JV. Periapical status and quality of root fillings and coronal restorations in an adult Spanish population. *Int Endod J*. 2004;37(8):525–530. doi:10.1111/j.1365-2591.2004.00826.x
20. Rincon Forero LM. *Characterization of patients attending the Endodontics Postgraduate Clinic of the Faculty of Dentistry, National University of Colombia, 2012–2015* [in Spanish]. Bogota, Colombia: National University of Colombia; 2016 [thesis].
21. Luna Jaramillo NA, Santacruz Insuasty AX, Palacio Córdoba BD, Mafla Chamorro AC. Prevalence of chronic apical periodontitis in endodontically treated teeth in the academic community at Universidad Cooperativa de Colombia, Pasto, 2008 [in Spanish]. *Rev Fac Odontol Univ Antioq*. 2009;21(1):42–49.
22. 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. doi:10.1111/j.1600-9657.1986.tb00119.x
23. Rodrigues Costa TH, de Figueiredo Neto JA, Figueiredo de Oliveira AE, de Figueiredo Lopes e Maia M, de Almeida AL. Association between chronic apical periodontitis and coronary artery disease. *J Endod*. 2014;40(2):164–167. doi:10.1016/j.joen.2013.10.026
24. Liljestrand JM, Mäntylä P, Paju S, et al. Association of endodontic lesions with coronary artery disease. *J Dent Res*. 2016;95(12):1358–1365. doi:10.1177/0022034516660509
25. Segura-Egea JJ, Jimenez-Moreno E, Calvo-Monroy C, et al. Hypertension and dental periapical condition. *J Endod*. 2010;36(11):1800–1804. doi:10.1016/j.joen.2010.08.004
26. Glickman GN. AAE Consensus Conference on Diagnostic Terminology: Background and perspectives. *J Endod*. 2009;35(12):1619–1620. doi:10.1016/j.joen.2009.09.029
27. Pasqualini D, Bergandi L, Palumbo L, et al. Association among oral health, apical periodontitis, *CD14* polymorphisms, and coronary heart disease in middle-aged adults. *J Endod*. 2012;38(12):1570–1577. doi:10.1016/j.joen.2012.08.013
28. de Oliveira BP, Câmara AC, Aguiar CM. Prevalence of asymptomatic apical periodontitis and its association with coronary artery disease in a Brazilian subpopulation. *Act Stomatol Croatia*. 2017;51(2):106–112. doi:10.15644/asc51/2/3

29. Ferreira-González I. The epidemiology of coronary heart disease. *Rev Esp Cardiol (Engl Ed).* 2014;67(2):139–144. doi:10.1016/j.rec.2013.10.002
30. Tibúrcio-Machado CS, Michelon C, Zanatta FB, Gomes MS, Marin JA, Bier CA. The global prevalence of apical periodontitis: A systematic review and meta-analysis. *Int Endod J.* 2021;54(5):712–735. doi:10.1111/iej.13467
31. López-López J, Jané-Salas E, Estrugo-Devesa A, et al. Frequency and distribution of root-filled teeth and apical periodontitis in an adult population of Barcelona, Spain. *Int Dent J*. 2012;62(1):40–46. doi:10.1111/j.1875-595X.2011.00087.x
32. Jiménez-Pinzón A, Segura-Egea JJ, Poyato-Ferrera M, Velasco-Ortega E, Ríos-Santos JV. Prevalence of apical periodontitis and frequency of root-filled teeth in an adult Spanish population. *Int Endod J*. 2004;37(3):167–173. doi:10.1111/j.0143-2885.2004.00759.x
33. Jakovljevic A, Nikolic N, Jacimovic J, et al. Prevalence of apical periodontitis and conventional nonsurgical root canal treatment in general adult population: An updated systematic review and meta-analysis of cross-sectional studies published between 2012 and 2020. *J Endod*. 2020;46(10):1371–1386.e8. doi:10.1016/j.joen.2020.07.007
34. Peters LB, Lindeboom JA, Elst ME, Wesselink PR. Prevalence of apical periodontitis relative to endodontic treatment in an adult Dutch population: A repeated cross-sectional study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2011;111(4):523–528. doi:10.1016/j.tripleo.2010.10.035
35. Moreno JO, Alves FR, Gonçalves LS, Martinez AM, Rôças IN, Siqueira Jr. JF. Periradicular status and quality of root canal fillings and coronal restorations in an urban Colombian population. *J Endod*. 2013;39(5):600–604. doi:10.1016/j.joen.2012.12.020
36. Archana D, Gopikrishna V, Gutmann JL, Savadamoorthi KS, Pradeep Kumar AR, Narayanan LL. Prevalence of periradicular radiolucencies and its association with the quality of root canal procedures and coronal restorations in an adult urban Indian population. *J Conserv Dent*. 2015;18(1):34–38. doi:10.4103/0972-0707.148888
37. Kielbassa AM, Frank W, Madaus T. Radiologic assessment of quality of root canal fillings and periapical status in an Austrian subpopulation – an observational study. *PLoS One*. 2017;12(5):e0176724. doi:10.1371/journal.pone.0176724
38. Connert T, Truckenmüller M, ElAyouti A, et al. Changes in periapical status, quality of root fillings and estimated endodontic treatment need in a similar urban German population 20 years later. *Clin Oral Investig*. 2019;23(3):1373–1382. doi:10.1007/s00784-018-2566-z
39. Berlin-Broner Y, Febbraio M, Levin L. Apical periodontitis and atherosclerosis: Is there a link? Review of the literature and potential mechanism of linkage. *Quintessence Int*. 2017;48(7):527–534. doi:10.3290/j.qi.a38162
40. Lockhart PB, Bolger AF, Papapanou PN, et al.; American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee of the Council on Cardiovascular Disease in the Young Council on Epidemiology and Prevention, Council on Peripheral Vascular Disease, and Council on Clinical Cardiology. Periodontal disease and atherosclerotic vascular disease: Does the evidence support an independent association? A scientific statement from the American Heart Association. *Circulation*. 2012;125(20):2520–2544. doi:10.1161/CIR.0b013e31825719f3
41. Tang K, Wu Y, Zheng Q, Chen X. Bibliometric research on analysis of links between periodontitis and cardiovascular diseases. *Front Cardiovasc Med*. 2023;10:1255722. doi:10.3389/fcvm.2023.1255722
42. Men B, Li Y, Jiang S. Updates on the role of periodontitis-related epigenetics, inflammation, oral microbiome, and treatment in cardiovascular risk. *J Inflamm Res*. 2024;17:837–851. doi:10.2147/JIR.S449661
43. An GK, Morse DE, Kunin M, Goldberger RS, Psoter WJ. Association of radiographically diagnosed apical periodontitis and cardiovascular disease: A hospital records-based study. *J Endod*. 2016;42(6):916–920. doi:10.1016/j.joen.2016.03.011
44. Caplan DJ. Chronic apical periodontitis is more common in subjects with coronary artery disease. *J Evid Based Dent Pract*. 2014;14(3):149–150. doi:10.1016/j.jebdp.2014.07.003
45. Hardan L, Matta A, Bourgi R, et al. Association between dental and cardiovascular diseases: A systematic review. *Rev Cardiovac Med*. 2023;24(6):159. doi:10.31083/j.rcm2406159
46. Malvicini G, Marruganti C, Leil MA, et al. Association between apical periodontitis and secondary outcomes of atherosclerotic cardiovascular disease: A case–control study. *Int Endod J*. 2024;57(3):281–296. doi:10.1111/iej.14018
47. Virtanen E, Nurmi T, Söder PÖ, Airila-Månsson S, Söder B, Meurman JH. Apical periodontitis associated with cardiovascular diseases: A cross-sectional study from Sweden. *BMC Oral Health*. 2017;17(1):107. doi:10.1186/s12903-017-0401-6
48. Frisk F, Hakeberg M, Ahlqwist M, Bengtsson C. Endodontic variables and coronary heart disease. *Acta Odontol Scand*. 2003;61(5):257–262. doi:10.1080/00016350310005510
49. Frisk F. Epidemiological aspects on apical periodontitis. Studies based on the Prospective Population Study of Women in Göteborg and the Population Study on Oral Health in Jönköping, Sweden. *Swed Dent J Suppl*. 2007(189):11–78. PMID:18047231.
50. Berlin-Broner Y, Febbraio M, Levin L. Association between apical periodontitis and cardiovascular diseases: A systematic review of the literature. *Int Endod J.* 2017;50(9):847–859. doi:10.1111/iej.12710
51. Lemagner F, Maret D, Peters OA, et al. Prevalence of apical bone defects and evaluation of associated factors detected with cone-beam computed tomographic images. *J Endod.* 2015;41(7):1043–1047. doi:10.1016/j.joen.2015.03.011
52. Hussein FE, Cheen Liew AK, Ramlee RA, Abdullah D, Chong BS. Factors associated with apical periodontitis: A multilevel analysis. *J Endod*. 2016;42(10):1441–1445. doi:10.1016/j.joen.2016.07.009
53. Alley BS, Kitchens GG, Alley LW, Eleazer PD. A comparison of survival of teeth following endodontic treatment performed by general dentists or by specialists. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2004;98(1):115–118. doi:10.1016/j.tripleo.2004.01.004
54. Lazarski MP, Walker 3rd WA, Flores CM, Schindler WG, Hargreaves KM. Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. *J Endod*. 2001;27(12):791–796. doi:10.1097/00004770-200112000-00021
55. Burry JC, Stover S, Eichmiller F, Bhagavatula P. Outcomes of primary endodontic therapy provided by endodontic specialists compared with other providers. *J Endod*. 2016;42(5):702–705. doi:10.1016/j.joen.2016.02.008