

Non-surgical endodontic retreatment in the resolution of apical periodontitis: a literature review*

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ABSTRACT

The aim of this study was to evaluate the efficacy of non-surgical endodontic retreatment in resolving apical periodontitis, considering bacterial reduction, postoperative pain control, and periapical healing. Thirty-five articles selected from PubMed, Scopus, and Embase up to October 2024 were reviewed, applying inclusion and exclusion criteria. The studies analyzed covered disinfection protocols (sodium hypochlorite, chlorhexidine, laser, and ozonated irrigants), obturation techniques, success and failure rates, and the elimination of resistant microorganisms such as *Enterococcus faecalis* and *Fusobacterium nucleatum*. The findings indicate that the use of advanced technologies, such as 980-nm diode laser and ozonated irrigants, enhances disinfection and promotes periapical repair. Likewise, ultrasonic and manual activation of irrigants proved effective in reducing bacteria and relieving postoperative pain; however, the heterogeneity of the protocols highlights the need to establish evidence-based standardized guidelines to optimize outcomes. In conclusion, non-surgical endodontic retreatment is an effective alternative for managing apical periodontitis, especially when modern disinfection methods are used; nonetheless, further research is needed to consolidate clinical practice.

Keywords: endodontics; retreatment; apical periodontitis; postoperative pain.

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INTRODUCTION

Apical periodontitis is a significant clinical challenge in endodontics, characterized by persistent root canal infection and periapical tissue damage, even after initial treatment. In this context, nonsurgical endodontic retreatment has emerged as a key strategy to achieve apical healing and improve clinical outcomes by managing persistent infections and adequately sealing the root canal system.

Pažin et al. (1) showed that although photodynamic therapy (PDT) used as an adjunct to ultrasonically activated irrigation (UAI) reduced periapical lesion volume in patients with apical periodontitis, its effectiveness did not significantly exceed that of the standard UAI protocol. Similarly, Katle et al. (2), in a prospective study, found that using irrigants such as sodium hypochlorite (NaOCl) or chlorhexidine (CHX) did not result in significant differences in radiographic treatment success, underscoring the importance of initial lesion size and appropriate surgical management in treatment outcomes.

Postoperative pain is another important factor to consider. In this regard, Sinha et al. (3), in a randomized clinical trial, reported that the use of ozonated irrigants in combination with standard retreatment protocols was effective in reducing postoperative pain compared with conventional irrigants. Similarly, they highlighted the benefits of ozone in managing periapical inflammation.

In terms of the effectiveness of filling materials, Sabeti et al. (4), in a systematic review and meta-analysis, concluded that calcium silicate-based bioceramic sealers provide outcomes comparable to those of other techniques and materials, with pooled failure rates below 7% in nonsurgical treatments.

On the other hand, systematic reviews such as that conducted by Del Fabbro et al. (5) have emphasized the need for further research to better understand the relative effectiveness of surgical versus nonsurgical approaches to the management of periapical lesions, highlighting the lack of conclusive evidence regarding specific techniques. In their narrative review, Cardinali et al. (6) emphasized that the success of endodontic retreatment depends significantly on individualized diagnosis and appropriate management of unfavorable anatomical conditions.

This narrative review synthesizes the most recent and relevant advances in the literature, addressing the effectiveness and challenges associated with nonsurgical endodontic retreatment in the resolution of apical periodontitis. By examining both clinical outcomes and future opportunities in this field, the review aims to provide practical and up-to-date guidance for endodontic clinical practice.

MATERIALS AND METHODS

Dental studies that critically evaluated the effectiveness of endodontic retreatment in resolving apical periodontitis were selected.

Search strategy

The search was conducted in three databases: PubMed, Scopus, and Embase, with no time restrictions. The search strategy was based on MeSH terms for PubMed and Scopus, and on specific terms for Embase (Table 1). The final search was conducted in October 2024, using EndNote (EndNote 21TM, Thomson Reuters; New York, USA) and Rayyan (QCRI, Khalid Mohammed; Qatar) software. The three authors of this study independently identified the articles, initially screening titles and abstracts to determine their relevance and assess eligibility criteria. Retrieved records were classified as “included” or “excluded.” The same three reviewers, following the same methodology, then assessed the full texts of the included records for further eligibility evaluation. Discrepancies in the evaluation were resolved through consensus.

For this purpose, two databases were created in Microsoft Excel (Office, Microsoft, Redmond, Washington, USA). The first was used to record and organize the studies selected for the final inclusion decision, documenting the title, authors, and DOI of each article. The second database was used to extract and systematize relevant information from primary studies and was divided as follows: authors, study type, study country, study objective, number of subjects, pulpal and periapical diagnosis, number of groups/sessions, hand or mechanical instruments, irrigants/adjunctive therapy, sealer/obturation technique, final restoration, statistical methodology, success rate, failure rate, reason for failure, and conclusions.

For systematic reviews and other secondary studies, the following additional variables were recorded: study title, authors, study type, journal, databases searched, eligibility criteria, number of included articles, quality or level of evidence reported by the authors, and main findings.

Selection criteria

Dental studies evaluating the effectiveness of nonsurgical endodontic retreatment in the resolution of apical periodontitis were selected, focusing on outcomes related to bacterial reduction, postoperative pain management, and clinical and radiographic healing of periapical lesions. Studies conducted in permanent teeth that employed advanced irrigation protocols, ultrasonic, manual, and laser-assisted adjunctive activation techniques, as well as bioceramic sealers, were included.

Table 1. Search strategy for descriptors in the different databases (through October 5, 2024).

Database	Search query	n
PubMed	((#1=("Periapical Periodontitides" OR "Periodontitides, Periapical" OR "Periodontitis, Periapical" OR "Periodontitis, Apical" OR "Apical Periodontitides" OR "Apical Periodontitis" OR "Periodontitides, Apical" OR "Periodontitis, Acute Nonsuppurative" OR "Acute Nonsuppurative Periodontitides" OR "Acute Nonsuppurative Periodontitis" OR "Nonsuppurative Periodontitides, Acute" OR "Nonsuppurative Periodontitis, Acute" OR "Periodontitides, Acute Nonsuppurative")) AND ((#2=("Retreatment")) AND ((#3=("Canal Therapies, Root" OR "Canal Therapy, Root" OR "Root Canal Therapies" OR "Therapies, Root Canal" OR "Therapy, Root Canal"))))	50
Scopus	(#1= TITLE-ABS-KEY ("Periapical Periodontitides" OR "Periodontitides, Periapical" OR "Periodontitis, Periapical" OR "Periodontitis, Apical" OR "Apical Periodontitides" OR "Apical Periodontitis" OR "Periodontitides, Apical" OR "Periodontitis, Acute Nonsuppurative" OR "Acute Nonsuppurative Periodontitides" OR "Acute Nonsuppurative Periodontitis" OR "Nonsuppurative Periodontitides, Acute" OR "Nonsuppurative Periodontitis, Acute" OR "Periodontitides, Acute Nonsuppurative")) AND (#2= TITLE-ABS-KEY ("Retreatment" OR "Secondary Treatment" OR "Endodontic Retreatment")) AND (#3= TITLE-ABS-KEY ("Canal Therapies, Root" OR "Canal Therapy, Root" OR "Root Canal Therapies" OR "Therapies, Root Canal" OR "Therapy, Root Canal"))	683
Embase	#1= ("Periapical Periodontitides" OR "Periodontitides, Periapical" OR "Periodontitis, Periapical" OR "Periodontitis, Apical" OR "Apical Periodontitides" OR "Apical Periodontitis" OR "Periodontitides, Apical" OR "Periodontitis, Acute Nonsuppurative" OR "Acute Nonsuppurative Periodontitides" OR "Acute Nonsuppurative Periodontitis" OR "Nonsuppurative Periodontitides, Acute" OR "Nonsuppurative Periodontitis, Acute" OR "Periodontitides, Acute Nonsuppurative") AND #2= ("Retreatment" OR "Secondary Treatment" OR "Endodontic Retreatment") AND #3= ("Canal Therapies, Root" OR "Canal Therapy, Root" OR "Root Canal Therapies" OR "Therapies, Root Canal" OR "Therapy, Root Canal")	9

Studies involving primary teeth, those that did not address relevant clinical or microbiological outcomes, investigations with insufficient follow-up to assess the resolution of apical periodontitis, and studies with uncontrolled methodological designs were excluded. Individual case reports and previously published systematic reviews or meta-analyses that did not provide new empirical data were also excluded.

Figure 1 presents the study selection flowchart. The search initially yielded 742 potentially relevant citations (PubMed: 50; Scopus: 683; Embase: 9). After removing duplicates (n = 45) and irrelevant articles

(n = 636), 61 citations met the eligibility criteria based on title and abstract screening. The final decision to improve the search for the most relevant articles was documented in Excel, leaving 35 articles to be reviewed in full text and evaluated using the qualitative synthesis analysis.

Information organization

Table 2 summarizes the *in vivo* studies and reports selected for this research. Table 3 summarizes the review articles included in the study.

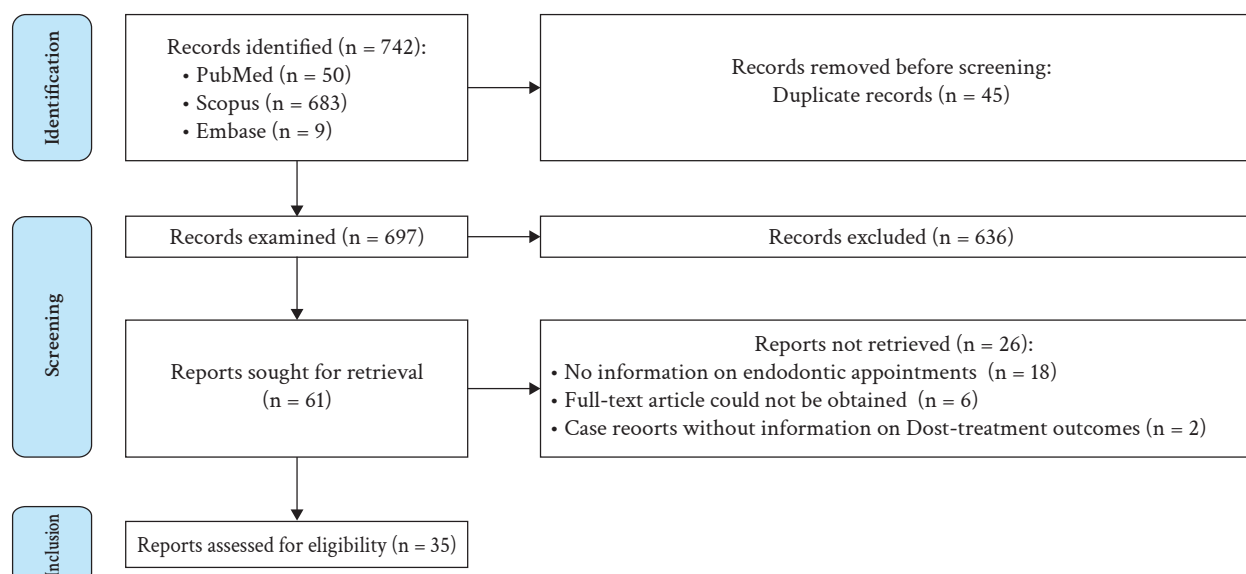
**Figure 1.** PRISMA flow diagram for the literature review.

Table 2. *In vivo* studies included in the review.

Authors and year	Study type	Country	Objective	Sample	Pulpal and periapical diagnosis	Number of groups/sessions	Hand or mechanical instruments	Irrigants/adjunctive therapy	Sealer/obturation technique	Final restoration	Statistical methodology	Success rate	Failure rate	Reason for failure	Conclusions
Pazin et al. (1)UAI, 2024	Randomized clinical trial	Croatia	To evaluate the effectiveness of photodynamic therapy in the healing of periapical lesions.	37 pts.	Chronic apical periodontitis	2 groups; single-visit treatment	Ultrasonically activated irrigation with NaOCl, EDTA, and diode laser-assisted PDT	3% NaOCl, EDTA, and diode laser-assisted PDT with ultrasonically activated irrigation	Epoxy resin-based sealer (AH Plus®); single-cone gutta-percha	Temporary glass ionomer restoration	Chi-square, Fisher's exact, and Fisher-Freeman-Halton tests	86.98% (lesion volume reduction in the group receiving UAI)	NS	NS	PDT did not significantly improve healing compared with UAI alone.
Katle et al. (2), 2024	Prospective cohort study	Norway	To compare radiographic outcomes using 1% NaOCl versus 2% CHX as irrigants.	200 t. (912 initially evaluated)	Primary and secondary apical periodontitis	2 groups	Rotary instruments	1% NaOCl, 2% CHX; calcium hydroxide	AH Plus®; lateral and vertical compaction	Glass ionomer or composite resin	Chi-square test, ANOVA, ordinal regression	70–80%, depending on the criterion	NS	Large initial lesions or high PAI scores	Both irrigants were equally effective in treatment.
Sinha et al. (3), 2024	Randomized clinical trial	India	To compare postoperative pain following ER using ozonated irrigants versus standard techniques.	132 pts.	Symptomatic apical periodontitis	2 groups; 1 appointment	NS	Ozonated irrigants; NaOCl and EDTA	NS; manual technique	Temporary crowns	Student's t test	76%	24%	NS	Ozonated irrigants are effective in reducing postoperative pain in ER cases.
Vieira et al. (7), 2024	Retrospective study	Brazil	To evaluate factors affecting treatment outcomes and nonsurgical ER.	304 t. (250 with primary treatment and 54 with retreatment)	Apical periodontitis with lesions >10 mm	Primary treatment and retreatment; 48.7% of cases required multiple sessions	NS	5.25% NaOCl, 17% EDTA	Kerr Pulp Canal Sealer™; warm vertical compaction	Adequate coronal seal	Logistic regression	74% (strict criterion) and 82% (lenient criterion)	26% (strict criterion)	Large lesions, overfilling	Large lesions, overextensions, and multiple visits reduce treatment success rates.
Sainudeen et al. (8), 2024	Retrospective study	India	To evaluate preoperative, intraoperative, and demographic variables affecting the success of ER.	500 pts.	Previously treated teeth with irreversible pulpitis and apical periodontitis	1 group	NS	NS	NS	NS	Multivariate models	50% complete healing and 30% partial healing	20% without healing	Apical periodontitis, canal morphology	Individualized treatment planning is key to improving ER success rates.
Terauchi et al. (9), 2023	Retrospective observational study	Japan	To examine the effects of MTA filling levels on ER outcomes.	264 t. (250 pts.)	Apical lesions ≥3 mm	3 groups (overfilling, flush filling, and underfilling); in a single appointment	NS	5.25% NaOCl, 3% H ₂ O ₂ ; ProRoot MTA	MTA; manual and rotary compaction	Definitive coronal seal	Linear regression, Kaplan-Meier analysis	93.2% overall (including surgery)	18.9% in the underfilling group	Large preoperative lesion, underfilling	MTA is effective; however, underfilled canals require additional interventions to achieve satisfactory outcomes.
Stueland et al. (10), 2023	Observational study	Norway	To compare surgical and nonsurgical ER outcomes in teeth with apical periodontitis.	458 t. (351 nonsurgical and 107 surgical)	Apical periodontitis in previously treated teeth	2 groups (surgical and nonsurgical)	NS	Bioceramic materials for retrograde filling	IRM and bioceramic materials; retrograde filling in surgical cases	NS	Logistic regression	65.5% nonsurgical and 77.6% surgical	34.5% nonsurgical and 22.4% surgical	Older age, high baseline PAI score	Surgical treatment has better overall outcomes, although factors such as age and preoperative PAI score negatively affect nonsurgical cases.

ER: endodontic retreatment; pts.: patients; t.: teeth; EDTA: Ethylenediaminetetraacetic acid; PDT: photodynamic therapy; UAI: activated ultrasonic irrigation; PAI: Periapical Index; EDDY: sonic irrigation activation system for endodontics; MTA: mineral trioxide aggregate; IRM: intermediate restorative material; SAF: self-adjusting file; TFA: Twisted File Adaptive; CBCT: Cone Beam Computed Tomography; NS: not specified.

Table 2. (Continuation).

Authors and year	Study type	Country	Objective	Sample	Pulpal and periapical diagnosis	Number of groups/sessions	Hand or mechanical instruments	Irrigants/adjunctive therapy	Sealer/obturation technique	Final restoration	Statistical methodology	Success rate	Failure rate	Reason for failure	Conclusions
İnce-Yusufoğlu et al. (11), 2023	Randomized clinical trial	Turkey	To compare postoperative pain between EDDY activation and manual irrigant activation in non-surgical endodontic retreatment.	60 t. in 60 pts. (30 per group)	Persistent apical periodontitis in previously treated teeth	Group 1: EDDY dynamic activation; Group 2: manual activation. Both treated in a single session	ProTaper rotary instruments	5.25% NaOCl and 17% EDTA; no intracanal medication was used.	AH Plus®; lateral compaction.	Composite resin.	Analysis of variance (ANOVA) and the Mann-Whitney test were used to compare differences between the groups.	Significant reduction in postoperative pain in the EDDY group compared with the manual group	NS	Not applicable (focus was on postoperative pain rather than treatment failure)	EDDY significantly reduces postoperative pain compared with manual activation during ER.
Pelozo et al. (12), 2023	Randomized clinical trial	Brazil	To determine the efficacy of a 980-nm diode laser as an adjunctive therapy in ER.	31 pts.	Asymptomatic apical periodontitis	2 groups; 1 session	Diode laser	Sterile saline	NS; conventional technique	Definitive crowns	ANOVA	88%	12%	NS	The 980-nm diode laser is effective as an adjunctive therapy in ER to improve periapical bone repair.
Tandon et al. (13), 2022	Double-blind <i>in vivo</i> clinical study	India	To evaluate bacterial reduction at different stages of ER using irrigation and intracanal medication protocols.	29 single-rooted t. with post-treatment apical periodontitis	Post-treatment apical periodontitis	2 groups (SmearOFFTM + CHX vs. NaOCl + Ca(OH) ₂); 1 appointment	Reciproc system, XP-Endo Finisher R	SmearOFFTM or NaOCl, CHX (Group 1); Ca(OH) ₂ (Group 2)	NS; lateral compaction	Glass ionomer	Mann-Whitney and Wilcoxon tests	SmearOFFTM significantly reduced <i>E. faecalis</i> and <i>F. nucleatum</i>	NS	NS	SmearOFFTM irrigation is more effective in reducing resistant bacteria such as <i>E. faecalis</i> , and 2% CHX is a medically intracanal recommended for ER.
Gonçalves et al. (14), 2021	Clinical case report	Portugal	To document nonsurgical ER of mandibular molars with a previously unidentified middle mesial canal.	3 clinical cases	Asymptomatic and symptomatic apical periodontitis	3 individual cases; multiple sessions	Reciproc R25/R40 and ProTaper Universal	5.25% NaOCl, 17% EDTA; calcium hydroxide	AH Plus®; continuous vertical compaction	Composite resin	Not applicable	Complete radiographic healing in both cases	NS	NS	Early identification of complex anatomical variations is essential for treatment success.
Toia et al. (15), 2021	Randomized clinical trial	Brazil	To compare the effectiveness of single- versus two-visit ER in reducing cultivable bacteria, endotoxins, and periapical lesion volume.	41 pts.	Post-treatment apical periodontitis	2 groups; 1 appointment vs. 2 appointments with calcium hydroxide	Chemomechanical preparation	NaOCl, EDTA; calcium hydroxide in the two-appointment group	NS	NS	Statistical tests comparing bacteriological and imaging parameters	Reduction in periapical lesions in both groups, with no significant differences	NS	NS	Retreatment in one or two appointments is equally effective for periapical healing at 18 months.

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Table 2. (Continuation).

Authors and year	Study type	Country	Objective	Sample	Pulpal and periapical diagnosis	Number of groups/sessions	Hand or mechanical instruments	Irrigants/adjunctive therapy	Sealer/obturation technique	Final restoration	Statistical methodology	Success rate	Failure rate	Reason for failure	Conclusions
Tosun et al. (16), 2022	Retrospective study	Turkey	To compare periapical trabecular patterns using fractal analysis on radiographs before and after nonsurgical endodontic retreatment.	50 pts.	Persistent apical periodontitis	1 group; 2 appointments	ProTaper Universal	5.25% NaOCl, 17% EDTA; calcium hydroxide	Adseal®; cold lateral compaction	Composite resin	Student's t-test, Pearson; fractal analysis	70% success according to PAI	30% of cases without complete healing	NS	Fractal analysis may be useful for predicting the prognosis of ER.
Dhanir et al. (17), 2021	Clinical case report	Indonesia	To evaluate the management of persistent pain in a previously treated tooth in an elderly patient with anxiety.	1 clinical case	Previously treated tooth with symptomatic apical periodontitis	1 clinical case	Reciproc R25; Hedstrom files	2.5% NaOCl	NS	Composite restoration	Not applicable	Clinical and radiographic success at 4-week follow-up	0%	NS	Conventional ER is effective for managing persistent pain in previously treated teeth.
Aga et al. (18), 2021	Retrospective study	United Arab Emirates	To evaluate the quality of ER and changes in periapical status.	239 radiographs	Apical periodontitis	1 group	Hand instrumentation	NS	NS; lateral compaction	NS	Mann-Whitney test	79% homogeneous root canal fillings	NS	Defective filling and loss of the coronal seal	ER significantly improves periapical quality and outcomes.
Krikheli et al. (19), 2021	Clinical case report	Russia	To present a clinical case of ER in a tooth with an extensive periapical lesion using MTA.	1 clinical case	Chronic apical periodontitis	1 clinical case	Rotary instruments	3% NaOCl, 17% EDTA; Calasept (calcium hydroxide)	Not applicable (MTA as permanent filling material); vertical compaction with MTA	Composite restoration	Not applicable	Radiographic evidence of complete healing at 6 months	NS	NS	MTA is an effective option for the management of extensive periapical lesions during ER.
Signor et al. (20), 2021	Retrospective study	Brazil	To investigate risk factors and patterns associated with technical quality and periapical healing following non-surgical ER.	322 t. (117 with complete follow-up)	Apical periodontitis, variations in canal curvature and morphology	1 group; multiple appointments	NS	2% NaOCl, EDTA; calcium hydroxide	NS; lateral compaction	Definitive coronal seal in 93.69% of cases	Logistic regression	80.5% periapical healing	19.5% healing failures	Extensive periapical lesions and altered morphology	Treatment predictability should consider the quality of the previous treatment and the morphological characteristics of the canal.
Bharti et al. (21), 2021	Randomized clinical trial	India	To evaluate the antimicrobial effectiveness of PDT, NaOCl, and CHX in the disinfection of previously treated root canals.	54 t.	Chronic apical periodontitis	3 groups; single-session treatment	NS	5% NaOCl, 2% CHX	NS	NS	Microbiological analysis and statistical tests for bacterial counts	99.74% elimination of <i>E. faecalis</i> in the PDT group	NS	NS	Photodynamic therapy is an effective alternative for disinfection during ER.

ER: endodontic retreatment; pts.: patients; t.: teeth; EDTA: Ethylenediaminetetraacetic acid; PDT: photodynamic therapy; AUI: activated ultrasonic irrigation; PAI: Periapical Index; EDDY: sonic irrigation activation system for endodontics; MTA: mineral trioxide aggregate; IRM: intermediate restorative material; SAF: self-adjusting file; TFA: Twisted File Adaptive; CBCT: Cone Beam Computed Tomography; NS: not specified.

Table 2. (Continuation).

Authors and year	Study type	Country	Objective	Sample	Pulpal and periapical diagnosis	Number of groups/sessions	Hand or mechanical instruments	Irrigants/adjunctive therapy	Sealer/obturation technique	Final restoration	Statistical methodology	Success rate	Failure rate	Reason for failure	Conclusions
Zhang et al. (22), 2020	Prospective cohort study	China	To investigate 4-year outcomes and prognostic factors of non-surgical ER.	98 t. (80 pts.)	Apical periodontitis	1 group; 2 sessions	ProTaper or Reciproc rotary instruments	5.25% NaOCl, 17% EDTA, and 2% CHX; calcium hydroxide	AH Plus®; warm vertical compaction	Glass ionomer or composite resin	Multivariate logistic regression	75.9% absence of radiolucencies	5.2% increase in radiolucencies	NS	Long-term outcomes of non-surgical ER are predictable, with a significant reduction in periapical radiolucencies.
Barbosa-Ribeiro et al. (23), 2020	Experimental clinical study	Brazil	To investigate the microbiota in teeth with persistent infection during different stages of retreatment.	20 t. with apical periodontitis	Persistent apical periodontitis	1 group; 3 stages	Reciproc R40	6% NaOCl, 17% EDTA; Ca(OH) ₂ + 2% CHX	Endomethasone sealer; single-cone	Composite resin	ANOVA and paired Student's t-test	99.5% bacterial reduction	NS	NS	Retreatment was effective in reducing bacterial load, although some species showed high resistance.
Alhar-moodi et al. (24), 2019	Retrospective study	United Arab Emirates	To evaluate the quality of ER and changes in periapical status.	200 t.	Apical periodontitis	1 group	Manual and NiTi instrumentation	NS	NE; lateral and vertical compaction	NS	Chi-square test	81% radiographic healing	NS	NS	ER in a specialized setting significantly improves periapical outcomes.
He et al. (25), 2017	Prospective cohort study	United States	To evaluate patient-centered clinical outcomes of molar retreatment using contemporary techniques.	64 pts. (52 t. analyzed)	Various diagnoses, including chronic apical periodontitis	1 group; 2 to 3 sessions	NiTi rotary instruments	5.25% NaOCl, 17% EDTA; calcium hydroxide	AH Plus® or Resilon®; warm vertical compaction	Full-coverage crowns	ANOVA, Fisher's exact test	90.4% overall success	9.6% persistence of lesions	NS	Non-surgical endodontic retreatment improves patients' quality of life and chewing ability.
Silva et al. (26), 2016	Experimental clinical study	Brazil	To compare the effectiveness of apical enlargement and supplementary preparation with SAF for endotoxin removal.	11 individual t.	Post-treatment apical periodontitis	1 group	NS	2.5% NaOCl, EDTA	NS	NS	Friedman and Wilcoxon tests	Significant reduction in endotoxins with apical enlargement	NS	NS	Apical enlargement is key to reducing endotoxins, whereas SAF showed no significant differences.
Nešković et al. (27), 2016	Prospective clinical study	Serbia	To evaluate the outcomes of ortho-grade retreatment based on clinical and radiographic criteria over a two-year period.	38 pts.	Teeth with periapical lesions and teeth without visible lesions	2 groups, with/without periapical lesions	Manual and mechanical instruments	NaOCl, EDTA; calcium hydroxide in the two-visit group	NS	Glass ionomer	Statistical tests comparing groups with and without lesions	93.3% in teeth without lesions; 67.6% in teeth with lesions	NS	Chronic periapical lesions	Retreatment success depends on the initial presence of periapical lesions and treatment quality.
Eyuboglu et al. (28), 2016	Retrospective clinical study	Turkey	To evaluate periapical complications and the success rate of single-visit ER.	173 pts., 234 t.	Persistent periapical lesions	1 group; single sessions	NS	NaOCl, EDTA	AH Plus®; single-cone gutta-percha	Composite resin	Statistical tests for complications and success rates	90.9% clinical success	9.1%	Lesions >5 mm	Single-session retreatment is feasible for lesions smaller than 5 mm.

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Table 2. (Continuation).

Authors and year	Study type	Country	Objective	Sample	Pulpal and periapical diagnosis	Number of groups/sessions	Hand or mechanical instruments	Irrigants/adjunctive therapy	Sealer/obturation technique	Final restoration	Statistical methodology	Success rate	Failure rate	Reason for failure	Conclusions
Rodrigues et al. (29), 2015	Comparative clinical study	Brazil	To compare the antibacterial effect of SAF and TFA systems in retreatment cases.	43 t. with apical periodontitis	Post-treatment apical periodontitis	2 groups: SAF and TFA	NS	2.5% NaOCl, 17% EDTA; calcium hydroxide	NE; single-cone technique	Composite resin	Wilcoxon and Mann-Whitney	94.8% bacterial reduction with TFA and 83.7% with SAF	NS	Persistent bacteria in inaccessible areas	Both instrumentation systems were effective, with no significant differences in their antibacterial efficacy.
Signoretti et al. (30), 2013	Clinical microbiological study	Brazil	To investigate viable bacteria in persistent lesions resistant to retreatment.	20 persistent apical lesions	Persistent periapical lesions	1 group	Hand instrumentation	NaOCl	NS	NS	Chi-square and Fisher's exact tests	NS	NS	NS	Gram-positive bacteria may persist outside the root canal and contribute to the persistence of lesions.
Metska et al. (31), 2013	Prospective study	The Netherlands	To evaluate volumetric changes in apical radiolucencies using CBCT after orthograde retreatment.	37 pts., 45 t.	Persistent apical periodontitis	1 group; single-session treatment	Passive ultrasonic irrigation	2% NaOCl, 17% EDTA	AH 26®; lateral or warm vertical compaction	Glass ionomer or composite resin	Wilcoxon test and intraclass correlation coefficient	Reduction in radiolucencies in 57% of teeth	Increase in radiolucencies in 20% of teeth	Larger periapical lesions	Orthograde retreatment is effective in reducing lesions in most cases.
Robazza et al. (32), 2013	Clinical case report	Brazil	To describe the ER of a type II <i>dens invaginatus</i> with gutta-percha overfilling and chronic apical periodontitis.	1 clinical case	Type II <i>dens invaginatus</i> with chronic apical periodontitis	1 clinical case	ProTaper rotary instruments	2.5% NaOCl, 17% EDTA; calcium hydroxide	Sealapex®; thermoplasticized technique	NS	Not applicable	Complete clinical success at 3 years	NS	NS	Conventional retreatment was effective in healing a complex case of <i>dens invaginatus</i> .
De Chevigny et al. (33), 2008	Prospective cohort study	Canada	To evaluate the 4–6-year outcome of orthograde retreatment and its predictors.	126 t. (383 pts.)	Post-treatment apical periodontitis	1 group	Rotary instruments, gutta-percha	NaOCl, CHX; calcium hydroxide	Various; lateral and vertical compaction	NS	Logistic regression	82% of teeth healed	NS	NS	The quality of the previous root filling and the number of treatment sessions significantly influence the outcome.
Ercan et al. (34), 2007	Retrospective clinical study	Turkey	To evaluate the effectiveness of the combination of Ca(OH) ₂ and 1% CHX as an intracanal medication during endodontic retreatment.	70 t.	Post-treatment periapical lesions	1 group; standardized treatment protocol	Manual preparation	2% CHX; Ca(OH) ₂ combined with 1% CHX	Sealapex®; lateral compaction	Composite resin	Descriptive and comparative analysis	64% complete healing	21.9%	Persistent infection; larger lesions	Ca(OH) ₂ and 1% CHX constitute an effective intracanal medication for disinfection during retreatment of teeth with periapical lesions.

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Table 3. Review articles included.

Authors	Year	Study type	Database considerations	Eligibility criteria	Number of articles included	Quality/level of evidence reported by the authors	Main findings
Cardinali et al. (6)	2014	Narrative review	Analysis of clinical cases and recent literature	Studies addressing the complexities associated with endodontic retreatment	Not specified	Information based on observational studies and systematic reviews	The success of retreatment depends on accurate anatomical diagnosis and the use of advanced technology. Complications associated with chronic apical periodontitis may negatively affect outcomes.
Del Fabbro et al. (5)	2016	Systematic review	MEDLINE, Embase, Cochrane Library, and clinical trial registries through 2016	Randomized clinical trials related to surgical and non-surgical retreatment of periapical lesions	20 studies	Low to very low, with high heterogeneity and methodological biases	No conclusive evidence was found to support the superiority of surgical treatment over non-surgical treatment. Modern materials, such as MTA, show better healing outcomes for periapical lesions compared with conventional gutta-percha.
Sabeti et al. (4)	2024	Systematic review and meta-analysis	MEDLINE, Embase, Cochrane Library, Scopus, Web of Science, and gray literature through March 2023	Clinical and retrospective studies on endodontic treatment using the single-cone technique and bioceramic sealers	5 studies	Predominantly low, due to methodological limitations and the small number of studies	The single-cone technique with bioceramic sealers shows outcomes comparable to those of other techniques and materials in the healing of periapical lesions. No significant differences were found in clinical and radiographic failure rates.
Alghamdi et al. (35)	2020	Systematic review	PubMed and Google Scholar between June and November 2019. Inclusion criteria: studies in English, published within the previous 10 years (2009–2019), and conducted in humans. Exclusion criteria: animal studies, reviews, and studies that did not include retrograde surgical treatment.	Based on the PRISMA guidelines, selecting original articles on retrograde surgical treatment of periapical lesions.	10 studies (n = 376)	The analysis included 1 randomized controlled trial, 2 prospective studies, 1 retrospective study, and 6 case reports. Short-term healing success was significant; however, further research is needed to determine long-term outcomes.	Retrograde surgical treatment is effective in accelerating the healing of periapical lesions during short-term follow-up. Modern microsurgical techniques showed high success rates compared with conventional orthograde treatments. Further research is suggested to establish clear parameters for the use of these techniques.

RESULTS

A total of 35 studies were included. Findings were synthesized to evaluate the effectiveness of nonsurgical endodontic retreatment in the resolution of apical periodontitis. Key outcomes focused on bacterial reduction, postoperative pain management,

and periapical healing, with success and failure rates expressed as ranges to account for methodological variability across studies.

Studies that employed ultrasonic activation of irrigants achieved bacterial elimination rates ranging from 80% to 95% and were particularly effective against resistant microorganisms such as *E. faecalis*. Adjunctive therapies, such as the use of a 980-nm

diode laser, further increased microbial elimination, achieving success rates of up to 97% in persistent infections.

Postoperative pain decreased significantly with the use of advanced irrigation protocols. Ozonated chlorhexidine solutions reduced pain in 65%–75% of patients, outperforming traditional irrigants such as sodium hypochlorite (NaOCl). Ultrasonic activation combined with ozonated irrigants reduced pain scores by up to 30% compared with baseline levels during the first 7 days after treatment.

Radiographic evaluation showed that smaller lesions (<5 mm) were completely resolved in 70%–85% of cases within 12 months, whereas larger lesions (>10 mm) showed partial resolution in 50%–70% of cases. Success rates were higher when bioceramic sealers were used for root canal obturation, achieving complete healing in 85%–93% of cases.

The use of cone-beam computed tomography (CBCT) significantly improved diagnostic accuracy and follow-up, with reported success rates of 85%–95% in complex cases involving accessory or lateral canals. CBCT-guided retreatment demonstrated greater periapical healing compared with two-dimensional radiographic techniques.

Lesion size, microbial resistance, and anatomical complexities were reported as the main determinants of treatment outcomes. Cases involving extensive periapical lesions or accessory canals showed failure rates of up to 30%, highlighting the importance of individualized treatment planning. Operator experience was also a key factor, with success rates of 85%–95% among experienced clinicians compared with 65%–80% among less-experienced operators.

Single-session protocols showed success rates comparable to those of multiple-session protocols (80%–90% versus 82%–92%, respectively). Single-session treatments offered additional advantages in terms of patient comfort and reduced clinical time without compromising treatment outcomes.

DISCUSSION

Nonsurgical endodontic retreatment has become an effective and less invasive alternative for managing apical periodontitis, a condition that represents a significant challenge due to the persistence of microorganisms within the root canal system and complications associated with failed treatments. This narrative review analyzes the contributions of relevant studies, highlighting advances in intracanal disinfection, postoperative

pain management, innovative materials, and advanced diagnostic methods.

Effective elimination of intracanal microorganisms is an essential requirement for successful retreatment. Rodrigues et al. (29) evaluated the effectiveness of mechanized systems combined with irrigants, such as sodium hypochlorite (NaOCl) and EDTA, demonstrating a significant reduction in bacterial load, even in cases involving persistent infections. This approach facilitates the elimination of resistant pathogens such as *E. faecalis* and *F. nucleatum*, which are commonly associated with endodontic failures.

The use of adjunctive technologies such as CBCT, as described by Zhang et al. (22), has improved diagnostic and monitoring capabilities by facilitating three-dimensional assessment of periapical lesions and their post-treatment progression. This prospective study reported healing rates exceeding 85% in complex lesions, underscoring the importance of integrating advanced diagnostic tools into clinical practice.

Postoperative pain remains a significant barrier to patient acceptance of retreatment. Ercan et al. (34) reported that the use of calcium hydroxide in combination with intracanal chlorhexidine had a marked anti-inflammatory effect, significantly reducing the incidence and intensity of pain in patients with large periapical lesions. This finding highlights the essential role of disinfection not only as a means of promoting healing but also as a strategy for improving the patient experience.

Furthermore, Stueland et al. (10) compared surgical and nonsurgical approaches to retreatment, emphasizing that nonsurgical techniques, particularly those involving ultrasonic activation of irrigants, are less invasive and associated with fewer postoperative complications while maintaining comparable success rates. In addition, bioceramic sealers are considered a preferred obturation option because of their ability to provide a hermetic apical seal and promote tissue regeneration. Signor et al. (20) reported clinical success rates exceeding 90% in cases in which bioceramic materials were used, highlighting their advantages over traditional sealers in terms of resistance to microleakage and biocompatibility.

Krikheli et al. (19), in turn, addressed cases involving extensive periapical lesions in which advanced instrumentation and irrigation techniques were combined, emphasizing the importance of tailoring protocols according to root canal morphology and lesion extent. This reinforces the need to adapt clinical strategies to complex clinical scenarios. Vieira et al. (7) found that lesions smaller than 5 mm have a significantly greater likelihood of complete resolution compared with lesions larger than 10 mm, which require longer follow-up and more intensive treatment protocols. This finding

further emphasizes the importance of early diagnosis and appropriate intervention.

Operator experience is another critical factor, as demonstrated by Sainudeen et al. (8), who showed that the implementation of advanced technologies, such as CBCT and ultrasonic activation, can overcome limitations associated with complex anatomy and improve clinical success rates even in challenging cases. These findings are consistent with those reported by Alghamdi et al. (35), who emphasized that, although modern techniques have significantly improved clinical outcomes, areas of uncertainty remain and warrant further investigation. These include protocol standardization, cost-effectiveness assessment of advanced technologies such as CBCT, and validation of new materials in long-term multicenter studies.

This review provides an updated overview of non-surgical endodontic retreatment for the resolution of apical periodontitis; however, it has certain limitations inherent to its design. Most of the studies reviewed had limited sample sizes and lacked long-term follow-up, restricting the assessment of the clinical and radiographic stability of treatment outcomes. Furthermore, some studies did not adequately control for potentially confounding variables, such as operator experience, root morphology, or the patient's systemic health status, all of which could influence the reported success rates. In addition, variability in diagnostic techniques, particularly the selective use of CBCT compared with conventional radiographs, may introduce bias into the assessment of periapical healing. Finally, the narrative nature of this review entails a risk of selection bias, as the inclusion of studies depends on the availability

and quality of the published literature. Future research should adopt prospective multicenter designs with standardized clinical protocols and longitudinal follow-up to more robustly validate the effectiveness of nonsurgical endodontic retreatment.

CONCLUSIONS

This manuscript analyzes the effectiveness of nonsurgical endodontic retreatment in the resolution of apical periodontitis, highlighting advances in intracanal disinfection, postoperative pain management, diagnosis, and bioactive materials. The findings demonstrate that this therapeutic approach is effective, particularly when protocols involving ultrasonic activation of irrigants, three-dimensional diagnosis using CBCT, and bio-ceramic sealers are incorporated.

Clinical and radiographic success rates exceed 85% in complex periapical lesions treated using contemporary techniques. Nevertheless, prognosis depends on determining factors such as the initial lesion size, operator experience, quality of the apical seal, and the presence of resistant microorganisms.

Despite technological advances, challenges remain in standardizing protocols, assessing the cost-effectiveness of advanced technologies, and validating outcomes in multicenter studies with extended follow-up.

In summary, nonsurgical endodontic retreatment constitutes an effective therapeutic alternative to manage apical periodontitis when performed using an evidence-based approach.

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