

One Visit, Sharper Eyes, Activated Irrigants: How Operating Microscopy, Laser-Activated Irrigation and CBCT Are Reshaping the Single-Visit Root Canal Treatment Debate — A 2026 Narrative Review

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Abstract

Background: Whether root canal treatment should be completed in one or more visits has been debated for decades. Since 2018, higher-quality evidence and new technologies (the dental operating microscope, cone-beam computed tomography and laser-activated irrigation) have changed the terms of that debate.

Materials and Methods: Narrative review updating a 2018 specialization monograph. PubMed/MEDLINE was searched to September 2026 for Cochrane and umbrella reviews, systematic reviews and randomized trials on visit number, and for clinical and mechanistic studies on magnification, CBCT, guided endodontics, Er:YAG laser-activated irrigation (PIPS/SWEEPS), photodynamic therapy, photobiomodulation and bioceramic sealers. Every reference was verified against its PubMed record.

Results: The 2022 Cochrane review (47 trials) found no difference in radiological failure (RR 0.93) but more pain within one week after single-visit treatment (RR 1.55), mainly in vital teeth; a 2026 umbrella review found no clinically important difference in pain. The first CBCT-based trial (2026) reported similar overall healing but numerically more complete healing with calcium hydroxide (50% vs 25%, not significant). Missed canals increase the odds of post-treatment apical periodontitis about sevenfold, and a microscope with ultrasonic troughing raised

MB2 detection from 40.4% to 88.5%. Er:YAG laser-activated irrigation reduced early pain compared with ultrasonic activation (SMD -0.58; strongest at 24–48 h), whereas diode lasers, photodynamic therapy and photobiomodulation showed no added benefit in single-visit protocols.

Conclusion: Visit number is less decisive than the quality of the single visit. Magnification and selective CBCT address the most common technical cause of failure; laser activation improves short-term comfort. Two visits remain justified when canals cannot be dried or large lesions are present.

Key Word: Root canal therapy; Single-visit endodontics; Dental operating microscope; Laser-activated irrigation; Cone-beam computed tomography; Postoperative pain.

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I. Introduction

Whether a root canal treatment should be completed in one appointment or spread over two or more has been argued for half a century. The practical attractions of the single visit are obvious: one anaesthetic, one rubber-dam placement, less chair time, no risk of leakage through a temporary restoration and an earlier start to the definitive coronal restoration. The biological objection is equally familiar: the necrotic, infected root canal system is an anatomically complex biofilm habitat, and an inter-appointment calcium hydroxide dressing was long regarded as the only reliable way to reduce the bacteria that chemomechanical preparation leaves behind.

The best-quality evidence now available no longer supports the idea that the number of visits is, by itself, the decisive variable. The 2022 update of the Cochrane review, which pooled 47 trials, found no difference in radiological failure between single- and multiple-visit treatment [1], and a 2026 umbrella review of twelve systematic reviews reached the same conclusion for post-operative pain [2]. At the same time, the first randomized trial to use cone-beam computed tomography (CBCT) to judge healing of necrotic teeth, published in 2026, reported numerically, though not significantly, more complete healing when calcium hydroxide was placed between visits [3]. The question has therefore moved on. It is no longer "one visit or two?" but "what must happen inside a single visit to make it biologically equivalent to two?"

This is where the technologies that have entered endodontic practice since the original version of this work (a 2018 specialization monograph) become relevant. The dental operating microscope (DOM) addresses the most common technical cause of failure, the missed canal, which is associated with a roughly sevenfold increase in post-treatment apical periodontitis [4]. CBCT lets the operator know before access how many canals to look for. Laser-activated irrigation (LAI) with erbium lasers, in the forms known as photon-induced photoacoustic streaming (PIPS) and shock wave-enhanced emission photoacoustic streaming (SWEEPS), aims to carry the irrigant into areas that files never touch, and it has been associated with less early post-operative pain than ultrasonic activation [5].

The aim of this narrative review is to update the single- versus multiple-visit evidence to 2026 and to examine critically whether, and how far, magnification, three-dimensional imaging, laser and photonic adjuncts, and bioceramic sealers can close the gap that the inter-appointment dressing was designed to fill.

II. Materials and Methods

This is a narrative review. The search of the original monograph (PubMed, 1975–2018, terms "single visit", "multiple visit", "endodontics", "biopulpectomy" and "necropulpectomy", plus endodontic textbooks and hand-searching) was repeated and extended to September 2026. New searches in PubMed/MEDLINE combined "single-visit", "multiple-visit", "root canal therapy", "postoperative pain" and "periapical healing" with the technology terms "dental operating microscope", "magnification", "second mesiobuccal canal", "cone-beam computed tomography", "guided endodontics", "laser-activated irrigation", "PIPS", "SWEEPS", "Er:YAG", "photodynamic therapy", "photobiomodulation" and "bioceramic sealer". Priority was given to Cochrane reviews, umbrella reviews, systematic reviews with meta-analysis and randomized clinical trials published between 2019 and 2026. Classic trials that shaped the debate were kept for historical context. Laboratory studies were included only where they explained a mechanism, and they are identified as such. Every reference was checked against its PubMed record. Records still in "online ahead of print" status are marked in the reference list.

III. The Biological Rationale Behind the Visit-Number Debate

Apical periodontitis is an infectious disease, and the aim of treatment is to reduce the intracanal microbial load below the level the host can control, then to entomb what remains under a hermetic filling. The argument for the single visit rests on two premises: that a thorough chemomechanical preparation with sodium hypochlorite leaves few viable bacteria, and that the bacteria left behind will be deprived of space and nutrients once the canal is filled. The argument for the multiple visit rests on the evidence that the first premise is only partly true.

A 2024 clinical microbiology study illustrates the point. In 40 teeth with chronic apical periodontitis treated in a single visit with modern rotary or reciprocating instrumentation and a final irrigation protocol, colony counts fell significantly after each step, yet no sample showed complete eradication of bacteria; 55 aerobic and anaerobic species were identified [6]. This is consistent with a much older observation. In Trope and colleagues' 1999 trial, teeth dressed with calcium hydroxide showed the greatest improvement in periapical index (74%), followed by one-visit teeth (64%), whereas teeth left empty between visits healed clearly worse; the authors calculated that groups of several hundred patients would be needed to show a significant difference [7]. The first meta-analysis of the topic, pooling three small trials (146 cases), actually found a 6.3% higher healing rate after single-visit treatment, with a confidence interval so wide (-20.3% to 7.8%) that no conclusion could be drawn [8].

The biological question, therefore, has never been settled by biology alone. It is an empirical question about whether the bacteria that survive a well-executed single visit matter clinically. As the following sections show, the answer increasingly depends on how well that single visit is executed.

IV. What the Clinical Evidence Says in 2026

A. Healing and tooth survival

The 2022 Cochrane review is the reference point [1]. It included 47 randomized or quasi-randomized trials (5,805 participants) and, importantly, excluded five earlier trials that had not used rubber dam and sodium hypochlorite, because they no longer reflected the standard of care. It found no difference in radiological failure after at least one year (RR 0.93, 95% CI 0.81–1.07; 13 studies, 1,505 teeth; moderate-certainty evidence) and no detectable difference in tooth extraction, although only two trials reported extraction (RR 0.46, 95% CI 0.09–2.50; very low certainty). Swelling or flare-up, analgesic use and sinus tract persistence also did not differ.

Individual trials agree. In a Hong Kong trial of 220 teeth followed for a mean of 29 months, success rates were 88.9% (single visit) and 87.4% (multiple visits), while mean chair time fell from 92.9 to 62.0 minutes [9]. In retreatment, a Turkish trial of 100 teeth with periapical lesions found failure in 4.5% of single-visit and 8.9% of two-visit cases at 24 months, a non-significant difference; lesion size and the length of the previous filling, not the number of visits, predicted the outcome [10].

The newest and methodologically most demanding trial adds an important nuance. Sabeti and colleagues randomized 59 patients with necrotic teeth and apical periodontitis to single-visit treatment or to two visits with calcium hydroxide for 10–14 days and assessed healing with CBCT after a mean of 2.8 years [3]. Under loose criteria (healed plus healing), the two strategies were practically identical (90% vs 86.4%). Under strict criteria (completely healed), however, the two-visit group reached 50% against 25% (RR 2.0, 95% CI 0.8–4.8; $P = .121$). The difference was not statistically significant and the trial was small (42 patients completed follow-up), so the authors rightly state that it demonstrates neither superiority nor equivalence. Still, it is the first signal from three-dimensional imaging that complete bone healing may be slower without a dressing, a signal that periapical radiographs, with their lower sensitivity, could not have detected in earlier trials.

B. Post-operative pain

Pain was the main clinical argument of the original monograph. The Cochrane review found no difference in pain up to 72 hours after obturation (RR 0.97; low certainty), but a higher proportion of patients reporting some pain within the first week after single-visit treatment (RR 1.55, 95% CI 1.14–2.09; 5 studies, 638 teeth; moderate certainty) [1]. Surprisingly, in subgroup analysis this excess was concentrated in vital teeth (RR 2.16) and in mechanically instrumented canals (RR 1.80). This contradicts the often-repeated idea, also present in the original monograph, that single-visit treatment of vital pulps is uncontroversial; the healing outcome is indeed equivalent, but a short-lived increase in discomfort should be expected and explained to the patient.

Other syntheses frame the same data differently. A 2025 systematic review found that eight trials showed no difference and six showed less pain after single-visit treatment, and attributed the inconsistency to heterogeneous pain scales and patient selection [11]. The 2026 umbrella review concluded that the higher-confidence reviews show no consistent or clinically important difference [2]. A classic Indian trial of 200 single-rooted teeth likewise found no difference in the incidence or intensity of post-obturation pain [12].

C. How trustworthy is the evidence?

A 2026 meta-research study offers a caution. Of thirteen systematic reviews with meta-analysis on this question, spin (a presentation that overstates or distorts the findings) was found in the abstracts of twelve and in the full texts of ten, and most reviews were rated as having low or critically low methodological quality under AMSTAR 2 [13]. This agrees with an earlier grading exercise using the Strength of Recommendation Taxonomy, which classified the entire body of evidence as, at best, level B, with no study reaching level A [14]. In practical terms: the equivalence of the two approaches is the best current estimate, not a proven fact.

D. Economic perspective

A German Markov model found that the cost-effectiveness differences between the two strategies were small and depended on the tooth: single-visit treatment was marginally cheaper and more effective for molars, whereas multiple visits were cheaper and retained single-rooted teeth longer (18.9 vs 15.1 years) [15]. The authors concluded that scheduling, patient preference and dentist preference should weigh in the decision. For public health systems in which each extra appointment has a real opportunity cost, this is a relevant finding.

Table 1. Key clinical evidence on single- versus multiple-visit root canal treatment (1999–2026).

Study	Design / sample	Main finding
Trope et al., 1999 [7]	RCT, 3 arms	Best PAI improvement with Ca(OH) ₂ (74%) vs one visit (64%); empty canals between visits worst; hundreds of patients needed for significance.
Sathorn et al., 2005 [8]	SR/MA, 3 RCTs, 146 cases	Healing 6.3% higher with single visit; not significant (95% CI -20.3% to 7.8%).
Wong et al., 2015 [9]	RCT, 220 teeth, mean 29 months	Success 88.9% vs 87.4%; chair time 62.0 vs 92.9 min.
Karaoğlu et al., 2022 [10]	RCT, 100 retreatments, 24 months	Failure 4.5% (single) vs 8.9% (two visits), not significant.
Mergoni et al., 2022 (Cochrane) [1]	SR/MA, 47 trials, 5,805 participants	No difference in radiological failure (RR 0.93); more pain within one week after single visit (RR 1.55), mainly in vital teeth.
Gupta et al., 2026 [2]	Umbrella review, 12 SRs	No consistent or clinically important difference in post-operative pain.
Pires et al., 2026 [13]	Meta-research, 13 SRs	Spin in 12 of 13 abstracts; most reviews of low or critically low quality.
Sabeti et al., 2026 [3]	RCT, necrotic teeth, CBCT follow-up, 2.8 years	Loose healing 90% vs 86.4%; strict (complete) healing 25% single vs 50% two visits (not significant).

Ca(OH)₂: calcium hydroxide; CBCT: cone-beam computed tomography; MA: meta-analysis; PAI: periapical index; RCT: randomized clinical trial; RR: risk ratio; SR: systematic review.

V. The Operating Microscope: Seeing the Anatomy a Single Visit Cannot Afford to Miss

If a single visit is to succeed without a dressing that diffuses into untouched spaces, every canal must be found, cleaned and filled at that one appointment. The missed canal is the most direct threat to that goal. A 2025 meta-analysis of eight CBCT studies, covering 9,983 root-filled teeth, found post-treatment apical periodontitis in 85.1% of teeth with a missed canal against 56.3% of those without (OR 7.17, 95% CI 4.55–11.29), with maxillary first molars the most frequent culprits [4]. In a cross-sectional CBCT study of 282 molars, a missed canal was associated with a tenfold higher odds of a periapical lesion (OR 10.0) and was the only factor that significantly increased lesion volume [16]. A Brazilian study of 1,000 mesiobuccal roots found a second mesiobuccal (MB2) canal in 54.9% of images, of which 83.5% had not been filled [17].

Magnification changes these numbers. In a 2026 two-factor experiment on 208 extracted maxillary first molars, MB2 canals were found in 40.4% of teeth under direct vision, 57.7% with ultrasonic troughing alone, 67.3% with the microscope alone and 88.5% when the microscope and troughing were combined; magnification (OR 3.90) and troughing (OR 2.54) each had an independent effect [18]. In a prospective clinical cohort of 124 molar retreatments, the combination of the microscope with an impedance-based electronic canal locator gave the highest detection efficiency, and the electronic device alone outperformed the naked eye, a finding the authors present as an option where a microscope is not available [19]. For lingual canals in mandibular incisors and premolars, sensitivity was 0.40 with direct vision, 0.59 with 6× loupes and 0.68 with a microscope, and the difference between loupes and microscope was not significant [20].

Two limitations must be stated clearly. First, these data measure canal detection, not healing; no randomized trial has yet compared single-visit outcomes with and without a microscope. Second, the Cochrane review of periapical surgery found no difference in healing among loupes, microscope and endoscope, although on low-quality evidence [21]. The reasonable inference is indirect but strong: magnification reduces the number of missed canals, missed canals are among the strongest predictors of failure, and the single visit, which cannot rely on a dressing to compensate, is the approach that benefits most from that reduction.

VI. CBCT and Guided Endodontics: Planning the Single Visit Before It Starts

The European Society of Endodontology recommends CBCT selectively, for cases in which conventional radiographs are inconclusive or the anatomy is expected to be complex, and notes that clinical studies have confirmed its positive effect on treatment planning and decision-making [22]. For the visit-number decision, a pre-operative scan has two uses: it reveals extra canals, calcifications and resorptions that would make a single session unrealistically long, and it establishes a three-dimensional baseline against which healing can later be measured, as the 2026 CBCT-based trial demonstrated [3].

In calcified canals, CBCT combined with an intraoral scan also allows printed access guides. In a controlled clinical trial of 133 teeth with pulp canal obliteration, the guided approach located the canal in 59 of 60 teeth without any perforation, whereas freehand treatment by a specialist using a microscope failed to locate the canal in seven of 73 teeth and perforated seven [23]. Guided access turns what might otherwise be a two- or three-visit search into a predictable procedure, although the authors stress that it demands an experienced operator and should be used with a microscope, not instead of one.

VII. Laser-Activated Irrigation and Other Photonic Adjuncts

A. Mechanism and disinfection

Erbium lasers (Er:YAG, 2,940 nm) are strongly absorbed by water. When pulsed at sub-ablative energies in the pulp chamber, they create rapidly expanding and collapsing vapour bubbles that drive the irrigant through the canal system; PIPS uses very short pulses from a tip placed in the chamber, and SWEEPS adds a second, timed pulse to amplify the shock wave. A 2025 systematic review of fifteen studies concluded that Er:YAG activation improved disinfection compared with conventional or ultrasonic irrigation, with PIPS and SWEEPS producing the greatest bacterial reduction, particularly in the apical third, and in some studies allowing lower sodium hypochlorite concentrations without loss of efficacy [24]. An earlier review of 48 studies reached similar conclusions for diode, Er,Cr:YSGG and Er:YAG protocols, but only ten of those studies were performed *in vivo* [25]. Laboratory results should also be kept in proportion: against a four-week *Enterococcus faecalis* biofilm from a clinical isolate, Er:YAG-activated hypochlorite reduced bacteria by 98.8%, only marginally more than ultrasonically activated hypochlorite (98.6%) [26].

Wavelength matters, and the laser literature is often discussed as if all systems were interchangeable. A 2026 comparative review of diode, Er:YAG and Nd:YAG systems, co-authored by the first author of the present article, concluded that no laser is unconditionally superior and that the choice should follow the clinical objective [27]. In that synthesis, Er:YAG-based activation (PIPS/SWEEPS) had the strongest support for disinfection and smear layer removal with minimal thermal risk to dentin; diode lasers offered deeper optical penetration into dentinal tubules and the most consistent evidence in pain control and primary-tooth pulpotomy; and Nd:YAG showed antimicrobial activity against polymicrobial infections mainly *in vitro*, with unresolved questions about dentin safety and a lack of standardized parameters [27]. For the single-visit protocol, which depends on maximizing disinfection within one appointment, this points to Er:YAG activation as the most rational laser option, with diode and Nd:YAG remaining adjuncts for specific indications.

B. Post-operative pain

The clinical outcome for which LAI has the most consistent evidence is early post-operative pain, which is precisely the weak point of single-visit treatment identified by the Cochrane review. A 2025 meta-analysis of seven randomized trials (490 teeth) found that LAI reduced pain compared with ultrasonically activated irrigation (SMD -0.58, 95% CI -0.94 to -0.22), with the largest effect at 24–48 hours (SMD -1.00) and with pulsed Er:YAG modalities (PIPS, SMD -1.10; SWEEPS, SMD -1.57), whereas diode lasers showed no effect (SMD 0.03) [5]. A systematic review limited to single-visit treatment (nine trials, 547 patients) confirmed faster pain reduction with LAI in the first 24–48 hours and comparable results with ultrasonic irrigation thereafter [28]. The apparent disagreement about diode lasers, which appear effective for pain in some syntheses [27] and ineffective in others [5], is largely explained by the comparator: diode activation reduces pain compared with plain needle irrigation [29], but not compared with ultrasonic activation [5]. Randomized trials that compared the techniques directly, in 200 mandibular premolars [30] and in 60 molars with symptomatic irreversible pulpitis [31], both ranked SWEEPS and PIPS ahead of ultrasonic and conventional needle irrigation.

The evidence is not uniformly positive. A review restricted to comparisons with needle irrigation judged five of six trials to be at high risk of bias and found no clear difference between PIPS and needle irrigation, while diode activation did reduce pain in the first 48 hours [29]. Analgesic consumption did not differ between groups in most trials [29,30]. An editorial commentary on the 2025 meta-analysis concluded that LAI offers a measurable short-term benefit but should not replace ultrasonic activation as the routine standard, given its cost and limited availability [32].

C. Photodynamic therapy and photobiomodulation

Two other light-based adjuncts have been tested specifically in single-visit protocols, with negative results. In a randomized trial of 36 single-visit retreatments of teeth with lesions larger than 5 mm, adding antimicrobial photodynamic therapy to ultrasonically activated irrigation did not improve healing measured volumetrically on CBCT after one year (lesion volume reduction 86.98% vs 79.72%; $P = .970$) [33]. A Brazilian double-blind trial of 70 single-rooted teeth with asymptomatic apical periodontitis treated in a single visit with foraminal enlargement found that photobiomodulation (photodynamic therapy plus low-level laser) did not reduce post-operative pain, tenderness, oedema or analgesic use [34].

Table 2. What each technology contributes to a single-visit protocol, and how strong the evidence is.

Technology	Contribution to the single visit	Best available evidence	Main limitation
Operating microscope ($\pm$ ultrasonic troughing)	Finds MB2 and accessory canals so that all canals are treated in one session	Detection studies: MB2 40.4% $\rightarrow$ 88.5% [18]; missed canal OR 7.17 for failure [4]	No RCT on healing; loupes may approach its performance for some canals [20]
CBCT (selective)	Pre-operative anatomy, case selection, 3D baseline for follow-up	ESE position statement [22]; CBCT-based RCT follow-up [3]	Radiation dose and cost; not for routine use
Guided endodontics	Predictable access to calcified canals in one session	Controlled trial: 59/60 located, no perforations [23]	Needs CBCT, scanner, printing and experience
Er:YAG LAI (PIPS/SWEEPS)	Irrigant penetration; less early pain	MA of 7 RCTs, SMD -0.58; strongest at 24–48 h [5]	Cost; heterogeneous protocols; no healing data vs dressing
Diode laser LAI	Tubular penetration; antibacterial adjunct	Pain benefit vs needle only [29]; none vs ultrasound [5]; wavelength comparison [27]	Beam divergence; inconsistent results
aPDT / photobiomodulation	Adjunctive disinfection / analgesia	Two RCTs, no benefit [33,34]	Not supported for routine use
Bioceramic sealers	Biocompatible, hydrophilic obturation in a single session	Less pain at 4–8 h in one RCT [35]; no difference in another [36]	Short follow-up; technique-sensitive with heat

aPDT: antimicrobial photodynamic therapy; ESE: European Society of Endodontology; LAI: laser-activated irrigation; MA: meta-analysis; MB2: second mesiobuccal canal; OR: odds ratio; SMD: standardized mean difference.

VIII. Bioceramic Sealers and the Obturation Step

Because the single visit ends with immediate obturation, the sealer is in contact with periapical tissues that may still be inflamed. Calcium silicate (bioceramic) sealers are attractive in this setting because of their biocompatibility and their tolerance of residual moisture. In a double-blind trial of 86 patients treated in a single visit, BioRoot RCS produced significantly less pain than an epoxy-resin sealer at 4, 6 and 8 hours [35]. In another 2026 trial of 72 single-rooted teeth obturated in one visit with continuous wave of condensation, no difference in pain was found among one epoxy-resin and two bioceramic sealers, and all pain had resolved by 48 hours [36]. The sealer, therefore, appears to influence at most the first hours after treatment, and heat-based obturation does not seem to cancel out the clinical behaviour of bioceramic materials.

IX. An Integrated, Technology-Assisted Decision Framework

Taken together, the evidence supports moving the decision away from a fixed rule ("vital pulp: one visit; necrotic pulp: two visits") towards a checklist of conditions that the single visit must satisfy. Table 3 summarizes a pragmatic framework derived from the studies reviewed. It is offered as a clinical reasoning aid, not as a validated guideline.

Table 3. A pragmatic decision framework for the number of visits in the technology era.

Clinical scenario	Suggested approach	Technology role and rationale
Vital pulp (irreversible pulpitis), anatomy fully negotiated	Single visit	Healing equivalent [1]; warn of possible pain in the first week; LAI or bioceramic sealer may shorten early discomfort [5,35].
Necrotic pulp, no or small lesion, all canals located under magnification, canal dry	Single visit is reasonable	Microscope $\pm$ troughing to exclude missed canals [18]; activated irrigation (ultrasonic or Er:YAG) to extend disinfection [24].
Necrotic pulp with large lesion	Shared decision; two visits with Ca(OH) ₂ remain a valid default	Strict CBCT healing numerically better with dressing [3]; evidence inconclusive either way.
Persistent exudate, canal cannot be dried, acute abscess with swelling	Two visits	Obturation conditions not met; dressing and drainage first.
Complex anatomy on CBCT, calcification, resorption	Plan by complexity; guided access where indicated	CBCT [22]; guided endodontics reduces failures to locate canals [23].
Retreatment, asymptomatic, with lesion	Single visit is acceptable	No difference at 24 months [10]; lesion size predicts outcome more than visit number.
Patient cannot return reliably (medical, social, access barriers)	Favour single visit when the above conditions allow	Fewer appointments, shorter overall chair time [9]; comparable cost-effectiveness [15].

X. Implications for Public and Resource-Limited Practice

Most of the technologies discussed here were developed and tested in specialist or university settings. In public services, where patients often face long waiting lists, lost workdays and transport costs for every return, the single visit has a value that clinical trials rarely measure: the patient who does not return for the second appointment. Yet the same services rarely have microscopes, CBCT or erbium lasers. Two findings are useful for them. First, a 6× loupe detected accessory lingual canals almost as well as a microscope [20], and an inexpensive electronic canal locator performed better than the naked eye in molar retreatment [19]; the first step towards a safer single visit does not have to be the most expensive. Second, ultrasonic activation, which is widely available, remains the pragmatic standard against which lasers are compared, and the difference between them is limited to the first two days after treatment [5,32]. Adding an ultrasonic tip and magnification to a public endodontic service may therefore offer a better return than investing in a laser, a conclusion consistent with the call, in the comparative laser review cited above, for cost-effectiveness and accessibility analyses before lasers are adopted in systems such as the Brazilian Unified Health System (SUS) [27].

XI. Limitations and Directions for Future Research

This review is narrative and does not claim the reproducibility of a systematic review. The evidence on each technology is dominated by surrogate outcomes (canal detection, bacterial counts, pain during the first week), and none of the laser trials was designed to test the specific hypothesis this review raises: that an optimized single visit (magnification plus activated irrigation) can match a two-visit protocol with calcium hydroxide in complete periapical healing. Such a trial should randomize necrotic teeth with apical periodontitis, use CBCT at baseline and at a minimum of two years, report strict and loose healing separately and be powered for non-inferiority. Pain outcomes should follow the standardized measures and time points recommended by the 2026 umbrella review [2], and future syntheses should be protected against the spin documented in this field [13]. Cost-effectiveness analyses that include the price of the equipment, and not only the number of visits, are also needed.

XII. Conclusion

In 2026, the best available evidence still shows no difference in radiological healing or tooth retention between single- and multiple-visit root canal treatment, and the difference in post-operative pain is small, transient and largely confined to the first week. What has changed is our understanding of the conditions under which a single visit is safe. Missed canals are one of the strongest predictors of failure, and magnification, with or without CBCT, considerably reduces them. Er:YAG laser-activated irrigation has the best evidence among the new adjuncts, but its demonstrated benefit is limited to less pain in the first 48 hours; photodynamic therapy and photobiomodulation have not shown additional benefit in single-visit protocols. The first CBCT-based trial suggests that complete healing of large lesions may be slower without an inter-appointment dressing, and this possibility has not been ruled out. The number of visits should therefore be the result of the case, not a doctrine: a single visit when every canal has been found, disinfected and dried, and two visits when any of these conditions cannot be met.

References

- [1] Mergoni G, Ganim M, Lodi G, Figini L, Gagliani M, Manfredi M. Single versus multiple visits for endodontic treatment of permanent teeth. *Cochrane Database Syst Rev.* 2022;12(12):CD005296. doi:10.1002/14651858.CD005296.pub4
- [2] Gupta R, Abraham D, Ahmad L, Puri A. Single-visit versus multiple-visit root canal therapy: post-endodontic pain outcomes from an umbrella review. *J Dent.* 2026;169:106637. doi:10.1016/j.jdent.2026.106637
- [3] Sabeti M, Kim H, Abbaker S, Karimpourtalebi N, Azarpazhooh A. Healing outcomes of single-visit and two-visit endodontic treatment for necrotic teeth with apical periodontitis: a randomized clinical trial. *J Endod.* 2026 [online ahead of print]. doi:10.1016/j.joen.2026.07.018
- [4] León-López M, Montero-Miralles P, Cabanillas-Balsera D, Saúco-Márquez JJ, Martín-González J, Segura-Egea JJ. Association between the presence of missed canals, detected using CBCT, and post-treatment apical periodontitis in root-filled teeth: a systematic review and meta-analysis. *J Clin Med.* 2025;14(16):5781. doi:10.3390/jcm14165781
- [5] Sabeti M, Harouni A, Gabbay J. Comparing ultrasonically activated irrigation and laser-activated irrigation for postoperative pain reduction in endodontics: a systematic review and meta-analysis of randomized controlled trials. *J Endod.* 2026;52(1):37-46. doi:10.1016/j.joen.2025.08.002
- [6] Sesar A, Budimir A, Anić I, Kapetanović Petričević G, Bago I. Antibacterial efficacy of rotary and reciprocating instrumentation techniques. *Acta Stomatol Croat.* 2024;58(3):245-254. doi:10.15644/asc58/3/5
- [7] Trope M, Delano EO, Ørstavik D. Endodontic treatment of teeth with apical periodontitis: single vs. multivisit treatment. *J Endod.* 1999;25(5):345-350. doi:10.1016/S0099-2399(06)81169-6
- [8] Sathorn C, Parashos P, Messer HH. Effectiveness of single- versus multiple-visit endodontic treatment of teeth with apical periodontitis: a systematic review and meta-analysis. *Int Endod J.* 2005;38(6):347-355. doi:10.1111/j.1365-2591.2005.00955.x
- [9] Wong AWY, Tsang CSC, Zhang S, Li KY, Zhang C, Chu CH. Treatment outcomes of single-visit versus multiple-visit non-surgical endodontic therapy: a randomised clinical trial. *BMC Oral Health.* 2015;15:162. doi:10.1186/s12903-015-0148-x
- [10] Karaoğlu F, Miçoğlu Kurt S, Çalışkan MK. Outcome of single- versus two-visit root canal retreatment in teeth with periapical lesions: a randomized clinical trial. *Int Endod J.* 2022;55(8):833-843. doi:10.1111/iej.13758
- [11] Kumar G, Jena S, Manila N, Fareed M, Karobari MI. Incidence of postoperative pain after single-visit and multiple-visit root canal therapy: a systematic review. *BMC Oral Health.* 2025;25(1):47. doi:10.1186/s12903-024-05412-1

- [12] Singh S, Garg A. Incidence of post-operative pain after single visit and multiple visit root canal treatment: a randomized controlled trial. *J Conserv Dent*. 2012;15(4):323-327. doi:10.4103/0972-0707.101888
- [13] Pires ALC, Galdino-Santos L, Loomans B, Pereira-Cenci T, Chisini LA, Pappen FG. Spin and methodological quality of systematic reviews and meta-analyses comparing single- and multiple-visit endodontic treatment: a meta-research study. *Aust Endod J*. 2026;52(2):654-665. doi:10.1111/aej.70087
- [14] De-Deus G, Canabarro A. Strength of recommendation for single-visit root canal treatment: grading the body of the evidence using a patient-centred approach. *Int Endod J*. 2017;50(3):251-259. doi:10.1111/iej.12621
- [15] Schwendicke F, Göstemeyer G. Cost-effectiveness of single- versus multistep root canal treatment. *J Endod*. 2016;42(10):1446-1452. doi:10.1016/j.joen.2016.06.013
- [16] Zargar N, Khosravi K, Zadsirjan S, Safi Y, Vatankhah M, Akbarzadeh Baghban A, Aghajani Varzaneh F. The association of endodontic prognostic factors with the presence of periapical lesion, its volume, and bone characteristics in endodontically treated molars: a cross-sectional study. *BMC Oral Health*. 2024;24(1):28. doi:10.1186/s12903-023-03818-x
- [17] Carrion SJ, Coelho MS, Soares AJ, Frozoni M. Apical periodontitis in mesiobuccal roots of maxillary molars: influence of anatomy and quality of root canal treatment, a CBCT study. *Restor Dent Endod*. 2022;47(4):e37. doi:10.5395/rde.2022.47.e37
- [18] Adiguzel M, Ozeken F. Diagnostic performance of magnification and ultrasonic troughing in detecting second mesiobuccal canals: a two-factor experimental study. *Cureus*. 2026;18(5):e108940. doi:10.7759/cureus.108940
- [19] Adigüzel M, Özeken F, Çapar İD, Arslan H, Dummer PMH. Accuracy of Micro Hole Negotiator and other techniques for detecting MB2 canals in maxillary molar retreatment: a prospective cohort study. *Aust Endod J*. 2026;52(1):178-184. doi:10.1111/aej.70043
- [20] Çulha E, Tunç F, Nahırcı M. Detection of lingual canal in mandibular single-rooted teeth using dental operating microscope and dental loupes: a comparative study. *BMC Oral Health*. 2026;26(1) [article number to be confirmed]. doi:10.1186/s12903-026-09038-3
- [21] Del Fabbro M, Corbella S, Sequeira-Byron P, Tsesis I, Rosen E, Lolato A, Taschieri S. Endodontic procedures for retreatment of periapical lesions. *Cochrane Database Syst Rev*. 2016;10(10):CD005511. doi:10.1002/14651858.CD005511.pub3
- [22] Patel S, Brown J, Semper M, Abella F, Mannocci F. European Society of Endodontology position statement: use of cone beam computed tomography in Endodontics. *Int Endod J*. 2019;52(12):1675-1678. doi:10.1111/iej.13187
- [23] Torres A, Dierickx M, Lerut K, Bleyen S, Shaheen E, Coucke W, Pedano MS, Lambrechts P, Jacobs R. Clinical outcome of guided endodontics versus freehand drilling: a controlled clinical trial, single arm with external control group. *Int Endod J*. 2025;58(2):209-224. doi:10.1111/iej.14157
- [24] Fiegler-Rudol J, Grzech-Leśniak Z, Tkaczyk M, Grzech-Leśniak K, Zawilska A, Wiench R. Enhancing root canal disinfection with Er:YAG laser: a systematic review. *Dent J (Basel)*. 2025;13(3):101. doi:10.3390/dj13030101
- [25] Asnaashari M, Sadeghian A, Hazrati P. The effect of high-power lasers on root canal disinfection: a systematic review. *J Lasers Med Sci*. 2022;13:e66. doi:10.34172/jlms.2022.66
- [26] Cheng X, Xiang D, He W, Qiu J, Han B, Yu Q, Tian Y. Bactericidal effect of Er:YAG laser-activated sodium hypochlorite irrigation against biofilms of *Enterococcus faecalis* isolate from canal of root-filled teeth with periapical lesions. *Photomed Laser Surg*. 2017;35(7):386-392. doi:10.1089/pho.2017.4293
- [27] Rodrigues AC, Melo MLS, Piasentin AZ, Arruda SA, Souza RS, Moura BF, Dalla EF, Nóbrega SLD. Laser-assisted root canal therapy: comparative efficacy of diode, Er:YAG, and Nd:YAG systems in endodontics. *IOSR J Dent Med Sci*. 2026;25(8 Ser. 2):1-5. doi:10.9790/0853-2508020105
- [28] Gulhane A, Sapkale KD, Sayed A, Ramugade M, Kamble S, Magar A. Comparative evaluation of the effectiveness of laser-assisted irrigation and ultrasonic irrigation on postoperative pain in single-visit endodontics: a systematic review. *Cureus*. 2025;17(5):e84947. doi:10.7759/cureus.84947
- [29] McGillivray A, Dutta A. The influence of laser-activated irrigation on post-operative pain following root canal treatment: a systematic review. *J Dent*. 2024;144:104928. doi:10.1016/j.jdent.2024.104928
- [30] Erkan E, Gündoğar M, Uslu G, Özyürek T. Postoperative pain after SWEEPS, PIPS, sonic and ultrasonic-assisted irrigation activation techniques: a randomized clinical trial. *Odontology*. 2022;110(4):786-794. doi:10.1007/s10266-022-00700-0
- [31] Mittal N, Baranwal HC, Gupta S, Shankari T, Gupta S, Kharat S. Comparative analysis of reduction in pain scores after single visit root canal treatment using endodontic irrigation protocols, namely, conventional needle irrigation, PUI, PIPS and SWEEPS: a randomized control trial. *J Conserv Dent*. 2023;26(2):143-149. doi:10.4103/jcd.jcd_450_22
- [32] Mishra L. Can lasers help reduce post-root-canal pain more than ultrasonics? *Evid Based Dent*. 2026;27(1):12-13. doi:10.1038/s41432-026-01203-5
- [33] Pažin B, Lauc T, Bago I. Effect of photodynamic therapy on the healing of periapical lesions after root canal retreatment: 1-year follow up randomized clinical trial. *Photodiagnosis Photodyn Ther*. 2024;45:103907. doi:10.1016/j.pdpdt.2023.103907
- [34] Guimarães LDS, da Silva EAB, Hespanhol FG, Fontes KBFD, Antunes LAA, Antunes LS. Effect of photobiomodulation on post-operative symptoms in teeth with asymptomatic apical periodontitis treated with foraminal enlargement: a randomized clinical trial. *Int Endod J*. 2021;54(10):1708-1719. doi:10.1111/iej.13593
- [35] Arul B, Krithikadatta J, Selvakumar RJ, Ramanujam P, Ashritha MCV, Velmurugan N, Ulaganathan S. Assessment of postoperative pain after the use of calcium silicate bioceramic sealer – BioRoot RCS: a double-blinded randomized clinical trial. *J Conserv Dent Endod*. 2026;29(1):65-71. doi:10.4103/JCDE.JCDE_602_25
- [36] Defişet M, Özata MY. Effect of continuous wave of condensation on postoperative pain using bioceramic versus resin sealers: a randomized clinical trial. *BMC Oral Health*. 2026 [online ahead of print]. doi:10.1186/s12903-026-09200-x