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POSTOPERATIVE PAIN AFTER SINGLE-VISIT VERSUS MULTIPLE-VISIT ROOT CANAL TREATMENT: A COMPREHENSIVE REVIEW OF THE LITERATURE

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Abstract

Background: *Postoperative pain is one of the most frequently reported and clinically significant sequelae of root canal treatment (RCT), with a reported prevalence ranging from roughly 3% to over 60% depending on the population, diagnosis, and assessment method used. Whether treatment is completed in a single visit or staged across multiple visits with an interappointment intracanal dressing remains one of the most debated procedural decisions in endodontics, and its influence on postoperative pain has been investigated extensively but inconclusively.*

Aim: *This review synthesizes the current evidence comparing postoperative pain, flare-up incidence, and analgesic consumption between single-visit and multiple-visit RCT, and examines the broader biological, procedural, and patient-related factors that modulate postoperative pain regardless of visit number.*

Review Methods: *A narrative synthesis was performed of randomized controlled trials, systematic reviews, and meta-analyses identified through PubMed, Scopus, the Cochrane Library, and Google Scholar, focusing on studies directly comparing single-visit and multiple-visit endodontic protocols and studies characterizing the mechanisms and predictors of post-endodontic pain.*

Summary of Findings: *The weight of current evidence, including multiple systematic reviews and meta-analyses, indicates no statistically or clinically significant difference in postoperative pain, flare-up incidence, or healing outcome between single-visit and multiple-visit RCT when instrumentation and irrigation protocols are standardized. Pain after RCT appears to be governed more strongly by factors such as preoperative pain status, pulpal and periapical diagnosis, apical extrusion of debris, instrumentation and irrigation technique, and patient-related variables than by the number of treatment visits itself.*

Conclusion: *Single-visit RCT can be considered a safe and effective alternative to multiple-visit RCT with respect to postoperative pain in most clinical scenarios, though case selection, operator skill, and adherence to biologically sound*

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instrumentation and disinfection principles remain the primary determinants of patient comfort and treatment success.

1. Introduction

Root canal treatment (RCT) remains the standard of care for teeth affected by irreversible pulpitis, pulpal necrosis, and apical periodontitis, and it is among the most frequently performed procedures in restorative dentistry. Despite continuous advances in instrumentation, irrigation, and obturation technology, postoperative pain — defined as pain occurring after chemomechanical preparation, whether or not obturation has been completed — continues to be reported by a substantial proportion of patients, with published prevalence estimates ranging widely from approximately 3% to over 60% depending on diagnosis, methodology, and follow-up interval (21,23,29). This pain typically peaks within the first 24 to 48 hours after treatment and resolves within a few days in most cases, but it can occasionally persist for a week or longer and, in a minority of patients, progress to a symptomatic flare-up requiring an unscheduled visit (17,24).

One of the most enduring debates in clinical endodontics concerns whether RCT should be completed in a single appointment (single-visit RCT) or staged across two or more appointments with an interappointment intracanal medicament, most commonly calcium hydroxide (multiple-visit RCT). Single-visit RCT offers clear advantages in efficiency, cost, and patient convenience, and eliminates the risk of interappointment coronal microleakage into the unobturated canal system. Multiple-visit RCT has traditionally been favored for cases with extensive periapical pathology or heavy intracanal bacterial load, based on the rationale that an interappointment antimicrobial dressing further reduces bacterial counts before obturation (1,3). However, whether this theoretical microbiological advantage translates into a measurable reduction in postoperative pain, flare-up incidence, or improved long-term healing has been the subject of numerous randomized trials and systematic reviews, often with conflicting conclusions.

This review aims to consolidate the existing body of evidence on postoperative pain following single-visit versus multiple-visit RCT, to examine the pathophysiological basis of post-endodontic pain, to identify the procedural and patient-related factors that most strongly influence its occurrence, and to translate this evidence into practical guidance for clinical decision-making.

1.1 Review Methodology:

A structured literature search was conducted across PubMed/MEDLINE, Scopus, the Cochrane Central Register of Controlled Trials, and Google Scholar using combinations of the terms "single-visit," "multiple-visit," "root canal treatment," "endodontic therapy," "postoperative pain," "flare-up," and "randomized clinical trial." Randomized controlled trials, systematic reviews, and meta-analyses published in peer-reviewed journals were prioritized, supplemented by seminal older studies frequently cited within this body of literature. Reference lists of identified systematic reviews were hand-searched for additional primary studies. Given the narrative nature of this review, no formal risk-of-bias scoring or meta-analytic pooling was performed; instead, findings are synthesized thematically.

2. Etiology and Pathophysiology of Postoperative Endodontic Pain

Post-endodontic pain arises predominantly from an acute inflammatory response within the periapical tissues, triggered by a combination of mechanical, chemical, and microbiological insults sustained during chemomechanical preparation. Mechanical trauma from instrumentation, extrusion of infected dentinal debris and irrigant beyond the apical foramen, and alteration of the intracanal microbial ecosystem all contribute to an inflammatory cascade characterized by the release of neuropeptides and inflammatory mediators from periapical nerve fibers, sensitizing local nociceptors and producing the sensation of pain (17,23,24). In teeth with pre-existing apical periodontitis, this inflammatory response is superimposed on an already inflamed periapical lesion, which may amplify the postoperative pain

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response relative to teeth with normal periapical tissues (23).

Bacterial and endotoxin extrusion is considered a particularly important contributor, as even meticulous instrumentation cannot entirely prevent apical extrusion of debris, and residual intracanal microorganisms that survive chemomechanical disinfection may proliferate between appointments in multiple-visit protocols if the canal is left unmedicated, or may persist despite treatment in either protocol if disinfection is incomplete (17,24). This mechanistic understanding underlies the biological rationale for both single-visit approaches (minimizing the number of instrumentation and irrigation episodes, and therefore extrusion events) and multiple-visit approaches (reducing residual bacterial load through an interappointment antimicrobial dressing).

3. Rationale for Single-Visit Versus Multiple-Visit Protocols

3.1 Single-Visit Root Canal Treatment:

Single-visit RCT is completed in one appointment encompassing access, chemomechanical preparation, and obturation, without an interappointment intracanal dressing. Proponents cite reduced total chairside time, fewer opportunities for coronal microleakage or bacterial re-entry into an unobturated canal system, improved patient convenience and reduced missed-appointment risk, and comparable or superior success rates reported in several outcome studies (1,7,11). Historically, concerns regarding single-visit treatment centered on the possibility of incomplete disinfection of complex canal anatomy and a theoretically higher flare-up risk, particularly in necrotic, symptomatic, or retreatment cases (16,18,19).

3.2 Multiple-Visit Root Canal Treatment:

Multiple-visit RCT incorporates an interappointment intracanal medicament, most commonly calcium hydroxide, intended to further reduce intracanal bacterial load, neutralize residual endotoxin, and promote periapical healing before the canal is permanently obturated. This approach has historically been preferred for teeth with extensive periapical radiolucencies, persistent exudate, or heavily infected necrotic pulps, based on the assumption that residual bacteria are the principal determinant of both healing failure and postoperative symptoms (1,5,6). However, this multi-appointment approach carries the added risks of interappointment flare-up, coronal leakage through provisional restorations, and patient attrition between visits.

4. Evidence from Randomized Controlled Trials

4.1 Trials in Necrotic Teeth and Apical Periodontitis:

Several randomized trials have directly compared postoperative pain in necrotic teeth with apical periodontitis treated in one versus two visits. Trope et al. found comparable healing outcomes between single- and multi-visit treatment of teeth with apical periodontitis, an early and influential study supporting single-visit protocols even in the presence of periapical disease (11). Molander et al. similarly reported no significant differences in postoperative signs and symptoms between one- and two-visit treatment of asymptomatic necrotic teeth (10). Penesis et al., in a one-year randomized controlled trial, found no significant difference in periapical healing between one-visit and two-visit treatment using a calcium hydroxide/chlorhexidine interappointment dressing, reinforcing that the additional antimicrobial step did not confer a measurable clinical advantage (13). Paredes-Vieyra and Enriquez likewise reported comparable success rates between single- and two-visit treatment of teeth with apical periodontitis (12).

El Mubarak et al. specifically evaluated postoperative pain and found a low overall incidence with no significant difference between single-visit and multiple-visit conventional RCT (9). AbdurRahman et al. compared multiple-visit treatment using triple antibiotic paste against single-visit treatment without an interappointment dressing in necrotic teeth with apical periodontitis, and found no statistically significant difference in postoperative pain at 24, 48, and 72 hours or at one week, concluding that

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the additional antimicrobial dressing did not reduce pain relative to single-visit treatment (14).

4.2 Trials Including Vital and Mixed Pulpal Diagnoses:

Wong et al. conducted a randomized trial comparing single- and multiple-visit non-surgical endodontic therapy across a broad patient population and found no significant difference in the prevalence of postoperative pain or overall success rate between groups, while single-visit treatment required substantially less total chairside time (7). Patil et al. similarly reported no clinically meaningful difference in postoperative pain incidence between single-visit and two-visit RCT in a randomized controlled trial (8).

4.3 Retreatment and Special Populations:

Evidence in non-surgical retreatment cases and specific populations (e.g., diabetic patients) is more limited but generally follows the same pattern seen in primary treatment, with most comparative trials failing to demonstrate a clear pain advantage for either single- or multiple-visit protocols, although a small number of retreatment studies report a lower incidence of postoperative pain with single-visit approaches, possibly reflecting differences in residual microbial load and case selection between studies.

5. Evidence from Systematic Reviews and Meta-Analyses

The earliest influential systematic review and meta-analysis by Sathorn, Parashos, and Messer (2005) found that single-visit RCT without an interappointment calcium hydroxide dressing achieved a slightly higher healing rate than multiple-visit treatment, contrary to the traditional assumption that additional disinfection steps would improve outcomes, although the authors cautioned that the quality of underlying evidence was limited (1). A companion systematic review by the same group focusing specifically on postoperative pain and flare-up found no consistent evidence that multiple-visit treatment reduced pain or flare-up incidence compared with single-visit treatment (2).

The Cochrane systematic review by Figini et al. similarly concluded that there was insufficient high-quality evidence to demonstrate a clinically important difference between single- and multiple-visit RCT in terms of clinical or radiographic success, and by extension, symptomatic outcomes (3). Su, Wang, and Ye's systematic review of healing rate and post-obturation pain reached a comparable conclusion, finding no significant difference in postoperative pain between single- and multiple-visit treatment of infected root canals (4). More recent systematic reviews, including that by Kumar et al. (2025), continue to report that the majority of included studies show no difference in postoperative pain incidence between single- and multiple-sitting RCT, although a subset of studies suggests somewhat lower post-obturation pain with single-visit treatment (15).

Taken together, the cumulative weight of systematic review-level evidence — spanning two decades of accumulating trial data — does not support the historical assumption that multiple-visit treatment with an interappointment antimicrobial dressing meaningfully reduces postoperative pain, flare-up incidence, or improves healing relative to well-performed single-visit treatment.

6. Factors Influencing Postoperative Pain Independent of Visit Number

A substantial body of evidence indicates that variables other than the number of treatment visits are the dominant determinants of postoperative pain. These factors are summarized below.

6.1 Preoperative Pain and Diagnosis:

Preoperative pain intensity is consistently identified as one of the strongest predictors of postoperative pain, with patients presenting with symptomatic pulpitis or symptomatic apical periodontitis reporting substantially higher postoperative pain than asymptomatic cases (23,25). Segura-Egea et al. and Alí et al. both demonstrated a strong positive correlation between preoperative and postoperative pain intensity, underscoring the influence of pre-existing periapical sensitization (23,25).

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6.2 Apical Extrusion of Debris and Irrigants:

Extrusion of infected dentinal debris, irrigants, and intracanal medicaments beyond the apical foramen is strongly associated with postoperative pain and flare-up, regardless of visit number. Instrumentation techniques and irrigation delivery systems that minimize apical extrusion (e.g., negative-pressure irrigation, careful working-length control) have been associated with reduced postoperative pain in multiple randomized trials (20).

6.3 Instrumentation System and Technique:

Meta-analytic evidence suggests that rotary and reciprocating nickel-titanium instrumentation systems are generally associated with lower postoperative pain than manual (hand) instrumentation, likely reflecting more consistent canal shaping and reduced apical extrusion (28,29). Differences between specific rotary and reciprocating systems appear less clinically significant than the broad distinction between mechanized and manual instrumentation (28).

6.4 Intracanal Medicaments and Irrigation Protocol:

Where an interappointment dressing is used, the specific medicament appears to matter more than the mere presence of a dressing: combinations such as calcium hydroxide with chlorhexidine have shown modest pain-reducing effects in some systematic reviews, while other medicaments (including certain antibiotic pastes) have not been shown to outperform single-visit treatment without a dressing (14,26). Ultrasonically activated irrigation and lower sodium hypochlorite concentrations have also been associated with reduced postoperative pain in recent systematic reviews (26).

6.5 Tooth Type, Occlusion, and Procedural Factors:

Molar teeth, particularly mandibular molars, and teeth with heavy or premature occlusal contacts have been associated with a higher incidence of postoperative pain, and occlusal reduction has been proposed as a simple adjunct to reduce post-treatment discomfort. Procedural errors such as missed canals, ledging, or apical transportation are similarly associated with increased postoperative pain (26).

6.6 Patient-Related and Pharmacological Factors:

Patient age, sex, and anxiety level have all been reported to influence postoperative pain perception, with younger patients and women more frequently reporting higher pain scores in several cohorts (26). Preemptive administration of NSAIDs, particularly in combination with acetaminophen, and corticosteroids has shown low- to moderate-quality evidence of benefit in reducing postoperative endodontic pain and rescue-analgesic requirements, independent of the number of treatment visits (26,30).

7. Flare-Up Incidence: Single-Visit Versus Multiple-Visit

Flare-up, defined as the development of significant pain or swelling after treatment requiring an unscheduled visit, has historically been a central concern in the single- versus multiple-visit debate. Early studies by Walton and Fouad, and by Torabinejad et al., identified factors such as female sex, presence of preoperative swelling, retreatment status, and multi-visit protocols as potential flare-up risk factors, though findings across studies were inconsistent (16,19). Siqueira's review of the microbial causes of endodontic flare-ups emphasized that flare-ups are primarily driven by persistent or newly introduced intracanal infection and host immune response rather than by the number of appointments per se (17). Subsequent systematic review evidence, including Sathorn et al.'s dedicated review of flare-up prevalence, has not demonstrated a consistent or clinically significant difference in flare-up incidence between single- and multiple-visit protocols when modern aseptic and instrumentation standards are followed (2).

8. Analgesic Consumption and Pharmacological Pain Management

Across comparative trials, analgesic consumption generally mirrors reported VAS pain scores, with no consistent advantage for either single- or

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multiple-visit treatment. Where differences have been observed, they have typically been small in magnitude and inconsistent in direction across studies. Pharmacological management strategies — including preemptive NSAIDs, NSAID–acetaminophen combinations, and, in selected protocols, corticosteroids — have shown more robust and reproducible reductions in postoperative pain and analgesic requirement than the choice of single- versus multiple-visit protocol itself, suggesting that perioperative pharmacological management may be a more impactful lever for patient comfort than visit scheduling (26,30).

9. Quality of Life and Patient-Reported Outcomes

Beyond pain intensity scores, postoperative pain following RCT has been shown to meaningfully affect patients' short-term oral health-related quality of life, including chewing function, sleep, and daily activities, particularly during the first 48 to 72 hours after treatment. While direct comparative data on quality-of-life outcomes between single- and multiple-visit protocols remain limited, the convenience of completing treatment in a single appointment is itself frequently cited by patients as a quality-of-life benefit, independent of pain outcomes, given reduced time off work, travel, and cumulative anxiety associated with repeated dental visits (27).

10. Clinical Implications and Practice Recommendations

- For most cases of primary RCT, including many teeth with apical periodontitis, single-visit treatment can be performed without an expected increase in postoperative pain or flare-up risk, provided thorough chemomechanical disinfection is achieved.
- Multiple-visit treatment with an interappointment antimicrobial dressing may still be reasonable in select cases (e.g., extensive periapical pathology, difficulty achieving adequate disinfection in a single visit, or patient/operator preference), but should not be assumed to confer a pain-reduction advantage.
- Minimizing apical extrusion through careful working-length control, appropriate irrigation delivery, and mechanized instrumentation is likely to have a greater impact on postoperative pain than the number of visits chosen.
- Preoperative assessment of pain status and appropriate perioperative analgesic planning (e.g., preemptive NSAIDs) should be considered standard adjuncts regardless of the visit protocol selected.
- Clinicians should individualize the choice between single- and multiple-visit treatment based on case complexity, patient factors, and logistical considerations rather than an assumed pain-related benefit of either approach.

11. Limitations of Current Evidence and Future Research Directions

Despite the substantial volume of literature on this topic, several limitations constrain firm conclusions. Study heterogeneity in pain-assessment tools (VAS, NRS, verbal rating scales), follow-up intervals, operator experience, instrumentation systems, and case-selection criteria complicates direct comparison and pooled analysis across trials. Many trials are underpowered to detect small but clinically relevant differences in flare-up incidence, which is a relatively rare event. Blinding of both operator and patient to treatment allocation is inherently difficult in single- versus multiple-visit comparisons, introducing potential performance and detection bias. Future research would benefit from large, multicenter randomized trials with standardized pain-assessment protocols, pre-registered statistical analysis plans, and adequately powered flare-up outcomes, as well as further investigation of patient-specific predictors that could guide individualized visit-protocol selection.

12. Conclusion

The cumulative evidence from randomized controlled trials, systematic reviews, and meta-analyses accumulated over the past two decades does not support a clinically meaningful difference in postoperative pain, flare-up incidence, or analgesic consumption between single-visit and

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multiple-visit root canal treatment when contemporary instrumentation and disinfection protocols are followed. Postoperative pain is more strongly influenced by preoperative pain status, pulpal and periapical diagnosis, apical extrusion of debris, instrumentation technique, and patient-related factors than by the number of treatment appointments. These findings support single-visit RCT as a safe, efficient, and patient-convenient option for most cases, while multiple-visit treatment remains a reasonable and evidence-supported alternative in select complex cases. Continued high-quality research is warranted to refine case-selection criteria and further optimize perioperative pain management strategies across both treatment protocols.

Conflict of Interest and Funding

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