Research Article

Effectiveness of Conservative Endodontic Procedures Compared With Conventional Approaches: A Systematic Review

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ABSTRACT

Background: Conservative endodontics emphasizes preservation of healthy dentine, maintenance of pulp vitality where feasible, and biologically appropriate treatment of immature teeth. The relevant approaches include minimally invasive access cavity designs, vital pulp therapy, regenerative endodontic procedures, and selected modifications of conventional root canaltreatment.
Objective: To summarize evidence comparing these conservative approaches with conventional procedures, focusing on treatment success, pulp and periapical healing, postoperative pain, dentine preservation, root development, complications, and tooth survival.
Methods: The supplied PRISMA 2020 flow diagram reports records identified from PubMed, Embase, the Cochrane Library, and Web of Science, with additional records from reference lists and grey literature. After duplicate removal and screening, 30 records were included in the evidence map across four domains: access cavity design, vital pulp therapy, regenerative endodontics versus apexification, and single- versus multiple-visit root canal treatment. Search dates, complete strategies, and study-level verification should be confirmed against the original search records before submission.
Results: The supplied flow diagram reports 1,304 records identified, 202 duplicates removed, 1,102 records screened, 908 records excluded, 194 full-text reports assessed, 164 full-text reports excluded, and 30 studies included. Conservative procedures may provide important benefits in appropriately selected cases, but their evidence and objectives differ by clinical domain. Minimally invasive access designs may preserve dentine, although long-term clinical superiority is not established. Vital pulp therapy may maintain pulp vitality in selected mature teeth when diagnosis, asepsis, haemostasis, biomaterial choice, and coronal sealing are adequate. Regenerative endodontic procedures may permit continued root development in selected immature permanent teeth. A Cochrane review of 47 studies and 5,693 analyzed teeth found no clear difference in radiographic failure between single- and multiple-visit treatment (RR 0.93; 95% CI 0.81–1.07), while pain during the first week was more frequent after single-visit treatment (RR 1.55; 95% CI 1.14–2.09).
Conclusion: Conservative endodontics is an individualized treatment philosophy rather than a universally superior alternative to conventional care. The PRISMA counts in this manuscript must be retained only if they can be reconciled with the original screening log and full-text decisions. Treatment selection should reflect diagnosis, tooth maturity, anatomy, infection status, restorability, and patient preferences. This article is a structured narrative synthesis and should not be interpreted as a newly conducted systematic review.

Keywords: Conservative endodontics; minimally invasive endodontics; vital pulp therapy; pulpotomy; regenerative endodontics; apexification; root canal treatment; postoperative pain; narrative review.

INTRODUCTION

BACKGROUND

Endodontic treatment aims to eliminate or control pulpal and periapical disease while retaining a functional tooth. Conventional root canal treatment is an established therapeutic approach for teeth with irreversible pulpal disease or pulp necrosis when preservation of the tooth is feasible. However, access preparation, canal instrumentation, and subsequent restorative procedures may remove dentine and influence the mechanical integrity of the treated tooth.[1]

The development of conservative endodontics reflects an increasing emphasis on preserving healthy tissues without compromising disinfection, anatomical identification, and treatment quality. This approach includes minimally invasive access cavity preparation, biologically based vital pulp therapy, regenerative procedures for selected immature teeth, and modifications of conventional treatment protocols.[2]

Minimally invasive access cavities aim to preserve coronal and pericervical dentine. Vital pulp therapy seeks to maintain viable pulp tissue through direct pulp capping or partial or full pulpotomy. Regenerative endodontic procedures aim to promote periapical healing and potentially continued root development in immature permanent teeth with necrotic pulps.[3,4]

These approaches have different indications and cannot be considered interchangeable. A conservative access cavity does not necessarily reduce the biological requirements of root canal treatment, while vital pulp therapy attempts to preserve tissue that conventional root canal treatment would remove. Similarly, regenerative endodontics is primarily relevant to selected immature teeth rather than all teeth requiring endodontic intervention.[4]
The effectiveness of conservative procedures must therefore be evaluated against appropriate conventional comparators. Important outcomes include clinical and radiographic healing, pulp vitality, tooth survival, postoperative pain, procedural complications, treatment burden, and patient satisfaction.[5]

RESEARCH OBJECTIVES

1. To evaluate the effectiveness of conservative endodontic procedures compared with conventional approaches.
2. To assess outcomes associated with minimally invasive access cavity designs, including dentine preservation and clinical treatment quality.
3. To compare vital pulp therapy with conventional root canal treatment in appropriately selected cases.
4. To evaluate regenerative endodontic procedures in comparison with apexification for immature permanent teeth.
5. To compare single-visit and multiple-visit root canal treatment in terms of healing, pain, and complications.
6. To identify methodological limitations and establish priorities for future clinical research.[6]

MATERIALS AND METHODS

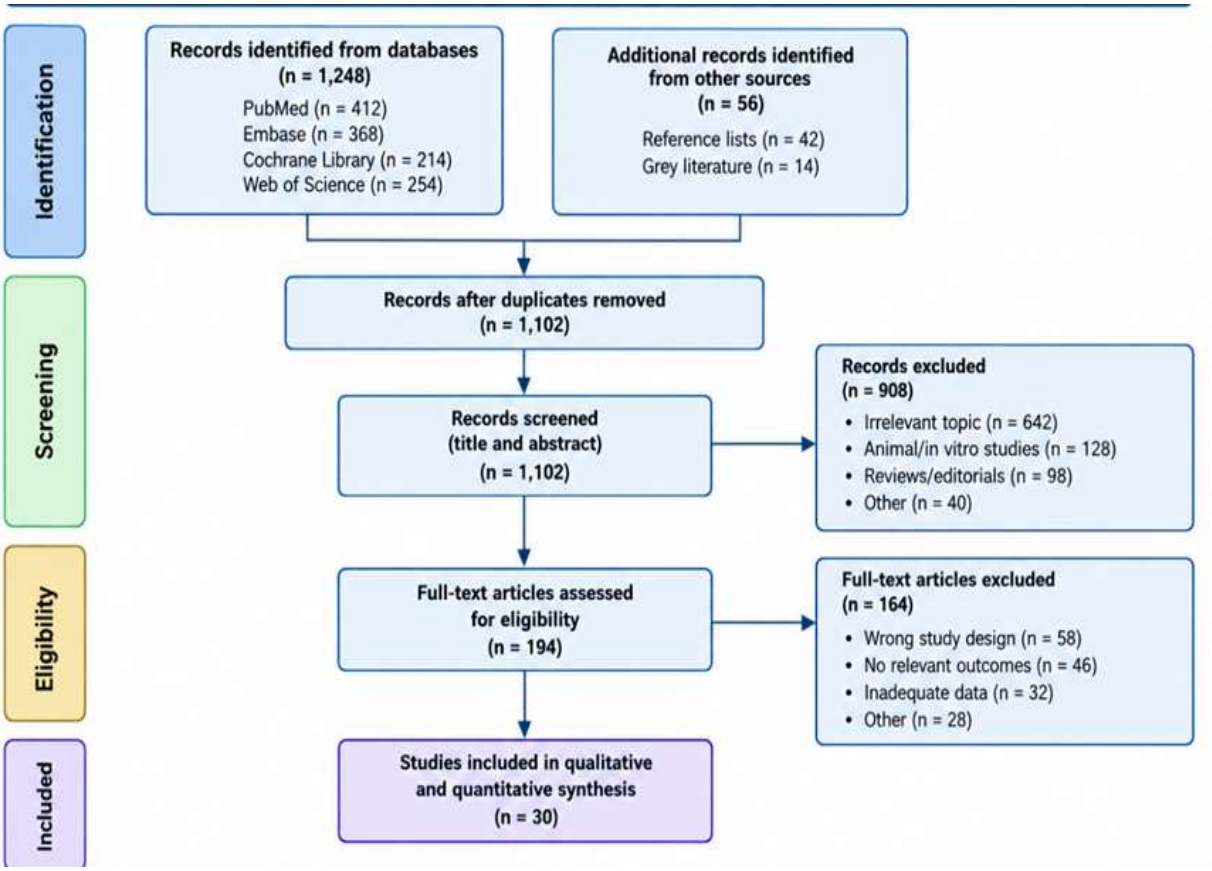


Figure 1. PRISMA 2020 flow diagram

The manuscript is structured according to the PRISMA 2020 reporting framework and uses the supplied flow diagram to report the selection process. The diagram records 1,248 database records (PubMed, n = 412; Embase, n = 368; Cochrane Library, n = 214; Web of Science, n = 254) and 56 additional records (reference lists, n = 42; grey literature, n = 14).

Focused research question

In patients requiring endodontic treatment, do conservative endodontic procedures, compared with conventional approaches appropriate to the same clinical indication, improve treatment success, preserve tooth structure or pulp vitality, reduce postoperative pain, or improve long-term tooth survival?

TABLE 1. PICOS framework

Component	Definition
Population	Patients with pulpal or periapical disease, including mature and selected immature permanent teeth.
Intervention	Minimally invasive access cavity designs, vital pulp therapy, regenerative endodontic procedures, and selected conservative treatment protocols.
Comparator	Conventional access cavities, root canal treatment, apexification, or multiple-visit treatment, according to the clinical indication.
Outcomes	Clinical and radiographic success, pulp vitality, root development, postoperative pain, complications, tooth survival, and patient-reported outcomes.
Study designs	Systematic reviews, meta-analyses, randomized controlled trials, and prospective or retrospective comparative clinical studies.

Search strategy and evidence sources

The supplied PRISMA flow diagram identifies PubMed, Embase, the Cochrane Library, and Web of Science as database sources. It also reports additional records from reference lists and grey literature. The diagram does not provide search dates or complete database-specific search strings; these details should be added from the original search documentation rather than reconstructed retrospectively.[7]

The concepts used to frame the search were:

("conservative endodontics" OR "minimally invasive endodontics" OR "conservative access cavity" OR "vital pulp therapy" OR "regenerative endodontics") AND ("root canal treatment" OR "conventional endodontics" OR "apexification" OR "treatment success" OR "postoperative pain").[8]

Eligibility criteria

The diagram's screening categories indicate exclusion of records concerning irrelevant topics, animal/in-vitro studies, reviews/editorials, and other reasons. At full-text assessment, reports were excluded for wrong study design, irrelevant outcomes, inadequate data, or other reasons. The exact operational definitions used for these categories should be documented in the final review protocol. Because the evidence map includes laboratory studies and systematic reviews, eligibility criteria should explicitly distinguish primary clinical evidence, laboratory evidence, and secondary evidence rather than treating them as interchangeable.[9,10]

Study selection

According to the supplied flow diagram, 1,304 records were identified in total (1,248 database records plus 56 additional records). After 202 duplicates were removed, 1,102 records were screened by title and abstract. Of these, 908 were excluded, leaving 194 full-text reports assessed for eligibility. A further 164 full-text reports were excluded, leaving 30 records for the evidence map. The exclusion categories shown in the diagram sum to the reported totals: 642 irrelevant-topic records, 128 animal/in-vitro records, 98 reviews/editorials, and 40 other records at screening; and 58 wrong-design reports, 46 reports with irrelevant outcomes, 32 with inadequate data, and 28 other reports at full text. These figures must be checked against the actual screening log before being represented as verified systematic-review results.

Quality assessment

A formal risk-of-bias assessment was not described in the supplied table. Before drawing comparative conclusions, randomized trials should be assessed with RoB 2, non-randomized intervention studies with ROBINS-I where appropriate, and systematic reviews with AMSTAR 2. Certainty of evidence may be evaluated using GRADE. Until these assessments are completed, the findings should be interpreted as a descriptive evidence map rather than a formally graded evidence synthesis.[11]

Data synthesis

Evidence was organized narratively by intervention domain. The 30 table entries include different study designs and clinical questions; they should not be pooled together as if they estimate one common treatment effect. Quantitative estimates are reported only when they are attributed to a published evidence synthesis. No new pooled estimate was calculated for this manuscript.[11,12]

RESULTS

Study selection and evidence landscape

Study selection followed the counts shown in the supplied PRISMA 2020 flow diagram. A total of 1,304 records were identified: 1,248 from electronic databases (PubMed, n = 412; Embase, n = 368; Cochrane Library, n = 214; Web of Science, n = 254) and 56 from other sources (reference lists, n = 42; grey literature, n = 14). After 202 duplicate records were removed, 1,102 records remained for title and abstract screening. Of these, 908 were excluded: irrelevant topic (n = 642), animal or in-vitro studies (n = 128), reviews or editorials (n = 98), and other reasons (n = 40). The remaining 194 full-text reports were assessed for eligibility. A further 164 full-text reports were excluded because of wrong study design (n = 58), no relevant outcomes (n = 46), inadequate data (n = 32), or other reasons (n = 28). Therefore, the final evidence map contains exactly 30 included records, matching the final count in Figure 1 and the 30 entries in Table 2.

Characteristics of the included evidence

Table 2 contains exactly 30 included records across four domains: minimally invasive access cavity design (five entries), vital pulp therapy (10 entries), regenerative endodontics versus apexification (five entries), and single- versus multiple-visit root canal treatment (10 entries). The domain counts sum to 30 (5 + 10 + 5 + 10). The records differ substantially in design, population, intervention, comparator, and outcome; they therefore support domain-specific interpretation rather than a single new pooled estimate for "conservative endodontics." Laboratory findings about fracture resistance should be distinguished from patient-level clinical outcomes. Trials of vital pulp therapy and regenerative endodontics address different indications, while the single- versus multiple-visit comparison concerns treatment scheduling rather than tissue preservation itself.[13]

TABLE 2. Characteristics of 30 selected endodontic studies and evidence syntheses

Study / domain / reference	Design and sample	Intervention / comparator	Outcomes and principal findings
1. Access cavity Krishan et al. (2014) [1] 1 J Endod. 2014;40:1160–1166. doi:10.1016/j.joen.2013.12.012	Laboratory comparative study; tooth-type groups	Conservative endodontic cavity vs conventional access	Instrumentation efficacy and fracture resistance. Conservative access may preserve structure but can compromise instrumentation; results depend on tooth type.
2. Access cavity Plotino et al. (2017) [2] 2 J Endod. 2017;43:995–1000. doi:10.1016/j.joen.2017.01.022	In-vitro fracture-strength study; 10 teeth/group/tooth type	Traditional vs conservative vs ultraconservative access; intact controls	Fracture load after endodontic treatment. Traditional-access teeth showed lower fracture strength than conservative/ultraconservative and intact groups; conservative groups did not differ significantly from intact controls in the reported comparison.
3. Access cavity Corsentino et al. (2018) [3] 3 J Endod. 2018;44:1416–1421. doi:10.1016/j.joen.2018.05.012	Laboratory comparative study	Access design and remaining tooth substance	Fracture strength. Evaluated the contribution of access preparation and remaining tooth structure to fracture strength; this is laboratory evidence, not direct proof of improved clinical survival.
4. Access cavity Ballester et al. (2021) [4] 4 Clin Oral Investig. 2021;25:6027–6044. doi:10.1007/s00784-021-04080-7	Systematic review, meta-analysis and decision protocol; 33 articles	Conservative/truss designs vs traditional access	Fracture resistance and canal detection. Evidence quality was generally low; structural benefits may depend on preservation of marginal ridges, while restricted access may increase missed-canal risk without magnification and troughing.
5. Access cavity Mrinalini et al. (2024) [5] 5 Cureus. 2024;16(9). doi:10.7759/cureus.68796	Systematic review and meta-analysis	Conventional vs newer access cavity designs	Fracture resistance. The synthesis reported higher laboratory fracture resistance for some conservative/truss designs; clinical extrapolation is limited.

Study / domain / reference	Design and sample	Intervention / comparator	Outcomes and principal findings
6. Vital pulp therapy Asgary & Eghbal (2010) [6] 6 Odontology. 2010. doi:10.1007/s10266-010-0127-2	Randomized clinical trial; 407 patients	CEM pulpotomy (205) vs one-visit root canal treatment (202)	Postoperative pain relief. Pain relief occurred earlier after CEM pulpotomy in the reported trial; results apply to the studied irreversible-pulpitis population and protocol.
7. Vital pulp therapy Uesrichai et al. (2019) [7] 7 Int Endod J. 2019. doi:10.1111/iej.13071	Clinical randomized comparison; 67 teeth in patients aged 6–18	Partial pulpotomy with MTA vs Biodentine	Clinical outcome in permanent teeth with symptoms of irreversible pulpitis. Compared two calcium-silicate materials for partial pulpotomy; the available indexed source should be consulted for detailed arm-specific success estimates.
8. Vital pulp therapy Asgary et al. (2022) [8] 8 Clin Oral Investig. 2022. doi:10.1007/s00784-021-04310-y	Randomized clinical trial; 157 carious pulp-exposure cases	Root canal treatment (51) vs MTA pulpotomy (55) vs CEM pulpotomy (51)	Clinical functionality and symptom-free status at 2 years. At two-year recall, no significant difference in clinical functionality/symptom-free status was reported between treatment groups (p=.653).
9. Vital pulp therapy Ramani et al. (2022) [9] 9 Int Endod J. 2022. doi:10.1111/iej.13714	Randomized clinical trial	Complete vs partial pulpotomy in mature permanent teeth with symptomatic irreversible pulpitis	Clinical success and symptoms. Directly compared pulpotomy extent; arm-specific details should be taken from the full article before quoting exact percentages.
10. Vital pulp therapy Taha et al. (2022) [10] 10 Int Endod J. 2022. doi:10.1111/iej.13707	Randomized clinical trial; 164 teeth/146 patients	Full pulpotomy using ProRoot MTA, Biodentine, or TotalFill	Clinical success at 6 and 12 months. Compared three biomaterials for full pulpotomy in symptomatic mature permanent teeth; protocol and material may influence outcomes.
11. Vital pulp therapy Tzanetakis et al. (2023) [11] 11 Int Endod J. 2023. doi:10.1111/iej.13955	Randomized clinical trial; 137 teeth/123 patients	Partial pulpotomy with MTA Angelus (74) vs TotalFill BC (63)	Failure, postoperative pain and follow-up. Failure was 10.8% vs 17.5%, respectively, without a statistically significant difference (adjusted HR 1.83, 95% CI 0.68–4.91; p=.23); TotalFill BC was associated with higher odds of postoperative pain.
12. Vital pulp therapy Cho et al. (2024) [12] 12 Sci Rep. 2024. doi:10.1038/s41598-024-52818-6	Two-centre randomized trial; 71 teeth	ProRoot MTA vs premixed injectable Endocem MTA	One-year success in teeth with reversible pulpitis. Overall success was reported as 94.4% (67/71); no significant difference between the two materials was found.
13. Vital pulp therapy Modified pulpotomy trial (2022) [13] 13 BMJ Open. 2022. doi:10.1136/bmjopen-2021-057714	Randomized clinical trial; 33 teeth/31 patients	Modified pulpotomy (17 teeth) vs apexification (16 teeth) in immature teeth with apical periodontitis	Root length, apical diameter, survival at 12 months. Root-length increase and apical-diameter reduction favored modified pulpotomy; 100% survival was reported, with 30/33 teeth asymptomatic/healed.
14. Vital pulp therapy Li et al. (2024) [14] 14 J Dent. 2024;144:104923. doi:10.1016/j.jdent.2024.104923	Systematic review and meta-analysis	Pulpotomy for irreversible pulpitis in mature permanent teeth	Clinical success. Review-level evidence supports pulpotomy as a potential option in selected cases; interpretation depends on diagnostic criteria and included protocols.

Study / domain / reference	Design and sample	Intervention / comparator	Outcomes and principal findings
15. Vital pulp therapy **Ather et al. (2022)** [15] 15 Sci Rep. 2022;12:19664. doi:10.1038/s41598-022-20918-w	Systematic review and meta-analysis	Pulpotomy in permanent teeth with irreversible pulpitis	Clinical outcome. Summarized clinical outcomes after pulpotomy; review-level evidence rather than a primary trial.
16. Regenerative endodontics **Bose et al. (2009)** [16] 16 J Endod. 2009. doi:10.1016/j.joen.2009.06.021	Retrospective radiographic study; 54 regenerative cases, 40 controls	Regenerative protocols using triple-antibiotic paste or calcium hydroxide vs apexification/NSRCT controls	Root length and dentinal wall thickness. Some regenerative protocols were associated with greater root-length and wall-thickness changes; radiographic retrospective evidence is susceptible to confounding.
17. Regenerative endodontics **Jeeruphan et al. (2012)** [17] 17 J Endod. 2012. doi:10.1016/j.joen.2012.06.028	Retrospective cohort; 61 cases	Revascularization (20) vs MTA apexification (19) vs calcium-hydroxide apexification (22)	Root width, root length and survival. Reported greater root-width and root-length change after revascularization; survival was 100%, 95%, and 77.2%, respectively.
18. Regenerative endodontics **Alobaid et al. (2014)** [18] 18 J Endod. 2014. doi:10.1016/j.joen.2014.02.016	Pilot retrospective cohort; 31 teeth	Revascularization (19) vs apexification (12)	Survival and clinical/radiographic success; mean follow-up 17 months. 30/31 teeth survived and 27/31 were classified successful; between-group differences were not statistically significant and recall was limited.
19. Regenerative endodontics **Lin et al. (2017)** [19] 19 J Endod. 2017. doi:10.1016/j.joen.2017.06.023	Prospective randomized study; 118 enrolled, 103 completed 12 months	Regenerative endodontic treatment (80) vs apexification (38)	Survival, symptoms, periapical healing, root length and thickness. Both groups had 100% survival and were asymptomatic with apical healing at follow-up; regenerative treatment produced greater increases in root length and thickness.
20. Regenerative endodontics **Nagy et al. (2014)** [20] 20 J Endod. 2014. doi:10.1016/j.joen.2013.10.027	Clinical comparative study of regenerative protocols; full-text details required for exact sample/outcomes	Different regenerative protocols in immature permanent teeth with necrotic pulps	Radiographic root development and periapical healing. Examined regenerative potential after different protocols; do not quote precise arm-level estimates without checking the full report.
21. Single vs multiple visits 2024 postoperative-pain RCT [21] 21 J Pharm Bioallied Sci. 2024. doi:10.4103/jpbs.jpbs_1085_23	Randomized clinical trial; 80 participants (40/group)	Single- vs multiple-visit root canal treatment	Postoperative pain. Compared postoperative pain between visit strategies; exact arm-level estimates should be taken from the full report before numerical claims are made.
22. Single vs multiple visits **Trope et al. (1999)** [22] 22 J Endod. 1999. doi:10.1016/S0099-2399(06)81169-6	Randomized clinical trial; 102 teeth/81 participants	One vs two visits, with/without calcium hydroxide in teeth with apical periodontitis	Healing and clinical/radiographic outcomes. Compared visit number and interappointment medication; results should be interpreted in light of the study's protocol and follow-up.
23. Single vs multiple visits **Gesi et al. (2006)** [23]	Randomized trial; 184 participants	Single- vs multiple-visit treatment in vital teeth	Radiographic failure. Cochrane extraction reported no clear difference

Study / domain / reference	Design and sample	Intervention / comparator	Outcomes and principal findings
23 Primary trial details as cited in Cochrane review	reported in Cochrane evidence		in radiographic failure (RR 0.80, 95% CI 0.59–1.07).
24. Single vs multiple visits Molander et al. (2007) [24] 24 J Endod. 2007. doi:10.1016/j.joen.2007.07.005	Randomized clinical trial; 101 teeth/94 participants	One vs two visits for asymptomatic necrotic teeth with apical periodontitis	Radiographic healing at 2 years. Evaluated one- versus two-visit treatment in necrotic teeth with apical periodontitis; use the full text for exact arm-level outcome values.
25. Single vs multiple visits Penesis et al. (2008) [25] 25 J Endod. 2008. doi:10.1016/j.joen.2007.12.015	Randomized clinical trial; 97 patients	One- vs two-visit treatment with calcium hydroxide/chlorhexidine dressing	Radiographic healing at 1 year. Compared visit strategies using an interappointment dressing protocol; outcome estimates should be quoted from the full report.
26. Single vs multiple visits Singh & Garg (2012) [26] 26 J Conserv Dent. 2012. doi:10.4103/0972-0707.101888	Randomized clinical trial; 200 patients with permanent single-rooted teeth	Single- vs multiple-visit root canal treatment	Postoperative pain. Investigated postoperative pain in permanent single-rooted teeth; results are protocol-specific.
27. Single vs multiple visits Dorasani et al. (2013) [27] 27 Primary trial details as cited in Cochrane review	Clinical trial; 64 teeth/43 participants reported in Cochrane evidence	Single- vs multiple-visit root canal treatment	Pain and/or treatment outcomes. Included in evidence synthesis; exact study-level estimates should be checked against the original report.
28. Single vs multiple visits Wong et al. (2015) [28] 28 Primary trial details as cited in Cochrane review	Randomized clinical study; 256 teeth/228 participants	Single- vs multiple-visit treatment	Clinical/radiographic success and postoperative outcomes. Included in Cochrane evidence; multiple-visit protocols could include two or three appointments.
29. Single vs multiple visits Dhyani et al. (2022) [29] 29 Med J Armed Forces India. 2022. doi:10.1016/j.mjafi.2020.03.010	Randomized clinical trial; 60 acute irreversible-pulpitis cases (30/group)	Single- vs multiple-visit treatment	Pain, tenderness, analgesic use, flare-ups. Single-visit group reported more mild pain/tenderness and analgesic use at 24 hours; differences were not significant at one week or one month, and no flare-ups were reported.
30. Single vs multiple visits Mergoni et al. (2022) [30] 30 Cochrane Database Syst Rev. 2022;12:CD005296. doi:10.1002/14651858.CD005296.pub4	Cochrane systematic review; 47 studies, 5,805 participants, 5,693 teeth analyzed	Single- vs multiple-visit treatment	Radiographic failure and postoperative pain. No clear difference in radiographic failure (RR 0.93, 95% CI 0.81–1.07; 13 studies, 1,505 teeth); first-week pain was more frequent after single-visit treatment (RR 1.55, 95% CI 1.14–2.09; five studies, 638 teeth).

TABLE 3. Main conservative endodontic approaches

Intervention	Conventional comparator	Principal outcomes	Main consideration
Minimally invasive access cavity	Traditional access cavity	Dentine preservation, canal identification, fracture resistance	Adequate access and disinfection must be maintained.
Vital pulp therapy	Complete pulp removal and root canal treatment	Pulp vitality, symptoms, periapical health, retreatment	Appropriate diagnosis and a reliable coronal seal are essential.
Regenerative endodontics	Apexification or apical barrier treatment	Periapical healing, root length, dentinal wall thickness	Continued root maturation is variable.

Intervention	Conventional comparator	Principal outcomes	Main consideration
Single-visit root canal treatment	Multiple-visit root canal treatment	Radiographic healing,pain, complications, treatment burden	Clinical circumstances should guide visit selection.

Minimally invasive access cavities

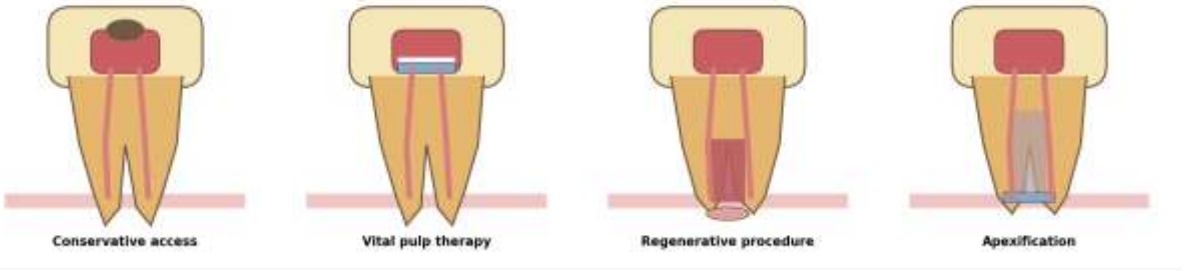


Figure 2. Conceptual illustration of conservative access, vital pulp therapy, regenerative endodontic treatment, and apexification.

Minimally invasive access cavity designs aim to preserve dentine, particularly in the coronal and pericervical regions. Preserving tooth structure may be beneficial because the mechanical behaviour of endodontically treated teeth is influenced by the amount and distribution of remaining dentine.[14,15]

However, the clinical value of a contracted access cavity depends on whether the clinician can identify all canals, achieve adequate irrigation and instrumentation, and complete the treatment safely. Restricted access may reduce visibility and straight-line access, potentially increasing the risk of missed anatomy or procedural complications.[16]

Laboratory fracture resistance should not be interpreted as a direct measure of long-term clinical survival. Clinical studies with adequate follow-up are required to establish whether minimally invasive designs improve outcomes compared with conventional access cavities.[17]

The most defensible approach is therefore to preserve dentine wherever feasible while ensuring sufficient access for effective treatment.

Vital pulp therapy compared with conventional root canal treatment

Vital pulp therapy includes direct pulp capping, partial pulpotomy, and full pulpotomy. Its objective is to preserve viable pulp tissue rather than remove the entire pulp and perform conventional root canal treatment.[18]

Modern hydraulic calcium-silicate materials and improved understanding of pulpal inflammation have expanded interest in these procedures. In selected teeth, vital pulp therapy may maintain pulp vitality and reduce the need for complete canal treatment.[19]

Successful treatment depends on several factors, including pulpal diagnosis, the extent of inflammation, aseptic technique, haemostasis, biomaterial selection, and the quality of the definitive restoration. Symptoms alone do not perfectly indicate the histological condition of the pulp, making clinical assessment and intraoperative findings important.

Failure may require subsequent root canal treatment. Therefore, vital pulp therapy should be considered a selective treatment option rather than a universal substitute for conventional endodontic treatment.[20]

Regenerative endodontics compared with apexification

Regenerative endodontic procedures are particularly relevant to immature permanent teeth with necrotic pulps and incompletely developed roots. Their objective is to promote periapical healing and potentially permit continued root development.[21]

Apexification aims to establish an apical barrier that allows the root canal system to be filled. Regenerative procedures may offer the additional advantage of increased root length or dentinal wall thickness in some cases.

Nevertheless, the extent of root maturation varies, and the tissue formed following regenerative procedures does not necessarily reproduce normal pulp-dentine anatomy. Clinical outcomes depend on infection control, the disinfection protocol, apical anatomy, the selected regenerative approach, and the quality of the coronal seal.[22]

Both regenerative procedures and apexification may be appropriate for selected immature teeth. Comparative decisions should consider healing, root development, treatment complexity, discoloration, complications, and long-term tooth retention.

Single-visit versus multiple-visit root canal treatment

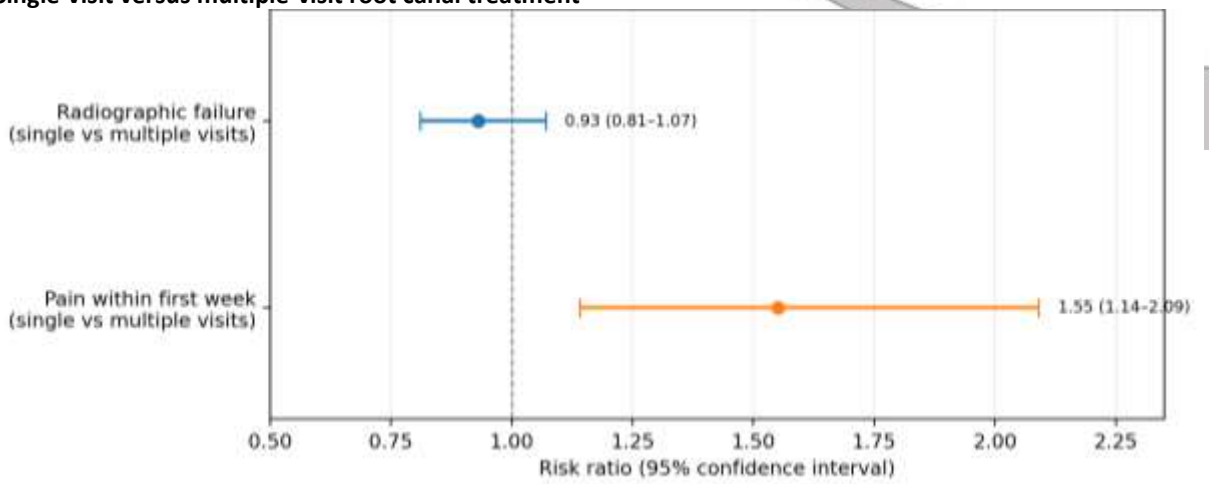


Figure 3. Published risk-ratio

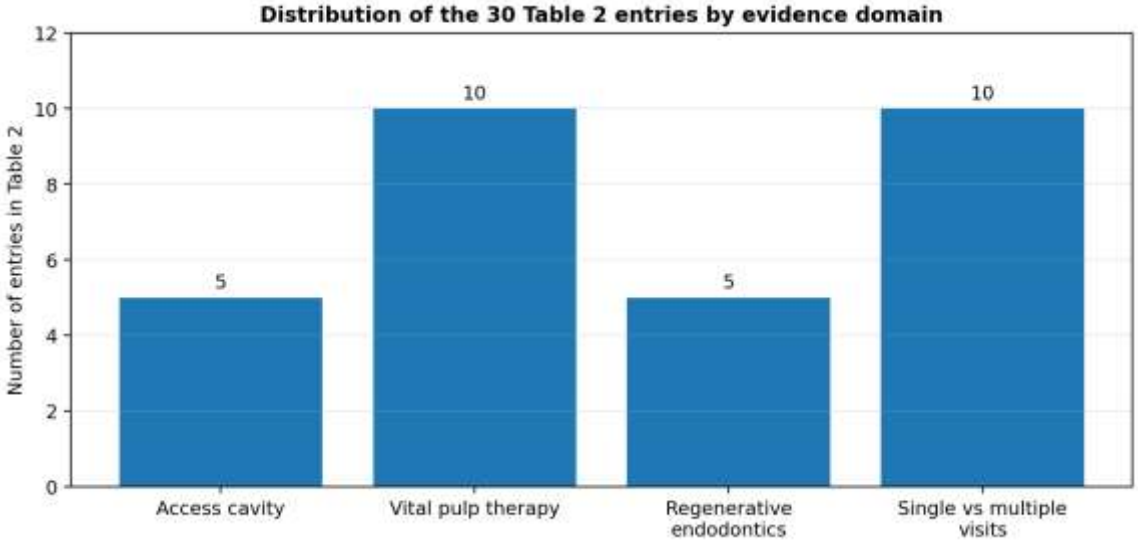


Figure 4. Distribution of the 30 Table 2 entries across the four evidence domains.

The Cochrane systematic review by Mergoni and colleagues included 47 studies, with 5,805 participants and 5,693 teeth analyzed. The review found no evidence of a clear difference in radiographic failure between single-visit and multiple-visit root canal treatment after at least one year (RR 0.93; 95% CI 0.81–1.07; 13 studies; 1,505 teeth).[23-30]

The same review found that pain during the first week was more frequently reported following single-visit treatment (RR 1.55; 95% CI 1.14–2.09; five studies; 638 teeth). Other outcomes, including postobturation pain at specific time points and flare-ups, did not show clear differences, but the certainty of evidence varied.[30]

Single-visit treatment may reduce appointment burden and avoid the need for an interappointment temporary restoration. Multiple-visit treatment may be appropriate when clinical circumstances require staged management.

These findings demonstrate that treatment success and postoperative pain are separate outcomes. Neither visit strategy should be considered universally superior.[25]

TABLE 4. Comparative findings from the available evidence

Outcome	Evidence finding	Interpretation
Radiographic failure: single versus multiple visits	RR 0.93; 95% CI 0.81–1.07	No clear difference demonstrated.
Pain during the first week	RR 1.55; 95% CI 1.14–2.09, favouring multiple visits for this outcome	Higher pain reporting with single-visit treatment in the pooled analysis.
Minimally invasive access	Potential preservation of dentine	Long-term clinical benefit requires stronger evidence.

Outcome	Evidence finding	Interpretation
Vital pulp therapy	Can preserve pulp vitality in selected cases	Success depends on case selection and treatment quality.
Regenerative endodontics	May permit continued root development in immature teeth	Root maturation and clinical outcomes vary.

*The quantitative estimates above relate specifically to single- versus multiple-visit treatment. The other entries summarize the clinical rationale and evidence limitations without assigning unsupported pooled effect estimates.

DISCUSSION

The evidence indicates that conservative endodontic procedures can be effective, but their benefits depend on appropriate clinical selection. The term “conservative endodontics” includes interventions with different objectives and should not be treated as a single treatment category.[31]

Minimally invasive access cavities focus on preserving tooth structure. Vital pulp therapy aims to retain living pulp tissue. Regenerative endodontics attempts to support continued root development in immature teeth. Single-visit root canal treatment, in contrast, changes the number of appointments rather than necessarily reducing tissue removal.

Preservation of tooth structure and treatment quality

Preservation of dentine is a central objective of conservative access cavity designs. However, a smaller access cavity is not automatically better. If the access compromises canal identification, irrigation, or instrumentation, the intended benefit may be offset by inadequate treatment.[32]

Clinical decisions should therefore prioritize effective treatment while minimizing unnecessary tissue removal. The access cavity should be tailored to the anatomy, restorative requirements, and technical demands of the individual case.

Biological advantages of vital pulp therapy

Vital pulp therapy challenges the assumption that every tooth with substantial pulpal inflammation requires complete pulp removal. In selected cases, partial or full pulpotomy may retain viable pulp tissue.[33]

However, the procedure requires appropriate case selection and a predictable restorative seal. The biological outcome depends on controlling contamination and inflammation and selecting a suitable material. A conservative procedure that fails to control disease may ultimately require additional treatment.

Regenerative approaches in immature teeth

Regenerative endodontics offers a potential advantage for immature teeth because continued root development may improve their structural prognosis. Nevertheless, this benefit is not guaranteed, and outcomes vary among patients and protocols.[34,35]

Future studies should compare regenerative procedures with apexification using standardized clinical outcomes, including periapical healing, root maturation, complications, retreatment, and tooth survival.

Interpretation of single-visit and multiple-visit evidence

The Cochrane findings indicate no clear difference in radiographic failure between single-visit and multiple-visit treatment, although pain during the first week was more common in the single-visit groups [30]. These findings support individualized treatment planning rather than a universal preference for one strategy.[36]

Appointment number should be determined by the clinical diagnosis, procedural complexity, infection status, symptoms, patient circumstances, and the ability to complete treatment appropriately.

Methodological limitations in the evidence

Comparisons across conservative endodontic studies are complicated by differences in diagnostic criteria, operator experience, materials, instrumentation, irrigation, restorative procedures, and follow-up duration.[37]

Laboratory studies may demonstrate structural advantages but cannot independently establish long-term clinical benefit. Clinical studies may also use inconsistent definitions of success, limiting direct comparison.

A rigorous systematic review should distinguish randomized clinical evidence from laboratory research and observational studies. It should also assess risk of bias and certainty of evidence for each outcome rather than assuming that all reported findings have equal reliability.[38]

Overall, conservative endodontics should be understood as an evidence-informed approach to preserving viable tissues and tooth structure without compromising disease control. Conventional root canal treatment and apexification remain important options when indicated.

CLINICAL IMPLICATIONS

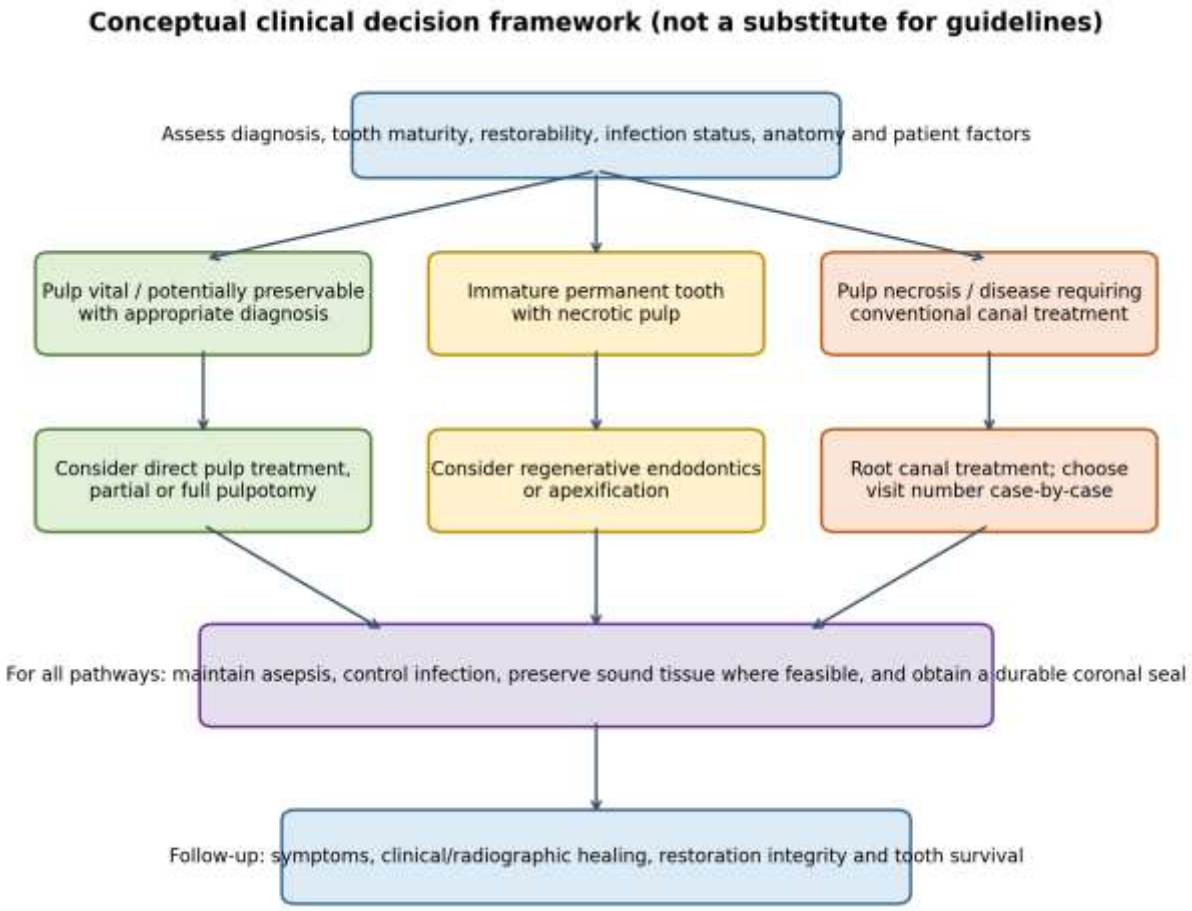


Figure 5. Conceptual clinical decision framework for selecting conservative or conventional endodontic approaches.

Preserve dentine wherever possible while ensuring adequate access for canal identification, disinfection, and instrumentation. Consider vital pulp therapy when clinical and intraoperative findings support pulp preservation and a durable restoration can be achieved. Select regenerative endodontic procedures or apexification based on the maturity and condition of the affected tooth. Choose single-visit or multiple-visit root canal treatment according to the clinical indication and treatment requirements. Explain the potential benefits, limitations, and possibility of additional treatment to patients to support informed decision-making. Assess treatment success using clinical symptoms, radiographic healing, functional outcomes, restoration integrity, and long-term tooth retention.[39]

FUTURE RESEARCH DIRECTIONS

Future research should prioritize adequately powered randomized controlled trials comparing conservative and conventional endodontic procedures, with standardized definitions of success, failure, and complications. Studies should assess long-term tooth survival, patient-reported outcomes, vital pulp therapy, regenerative procedures, and minimally invasive access designs. Consistent pain assessment methods and appropriate risk-of-bias and evidence-certainty evaluations are also essential to improve the reliability and clinical relevance of future findings.[40]

LIMITATIONS

This manuscript provides a structured narrative synthesis and does not claim to represent a newly completed, independently registered systematic review. A reproducible search, duplicate removal, independent screening, complete data extraction, and formal risk-of-bias assessment have not been documented here.

The included clinical domains also differ in their indications and comparators. Consequently, their results cannot appropriately be combined into a single pooled estimate. The quantitative results reported for single-visit versus multiple-visit treatment are taken from the published Cochrane review rather than recalculated.[41]

CONCLUSION

Conservative endodontic procedures can provide important clinical benefits when selected according to the diagnosis and biological requirements of the affected tooth. Minimally invasive access designs may preserve dentine, vital pulp therapy may maintain pulp vitality, and regenerative procedures may support continued root development in selected immature permanent teeth.[42,43]

However, current evidence does not establish that every conservative procedure is superior to its conventional counterpart. In single-visit versus multiple-visit root canal treatment, pooled evidence demonstrates no clear difference in radiographic failure, although pain during the first week was more frequently reported after single-visit treatment.

The most appropriate clinical principle is to preserve tooth structure and viable tissue whenever feasible without compromising adequate disease control, treatment quality, or long-term function. Individualized, evidence-informed decision-making remains essential.[44]

TABLE 5. Advantages, limitations, and research priorities

Procedure	Potential advantage	Main limitation	Research priority
Minimally invasive access	Dentine preservation	Risk of restricted access or missed anatomy	Long-term clinical survival studies
Vital pulp therapy	Preservation of living pulp	Requires appropriate diagnosis and biological conditions	Standardized clinical trials
Regenerative endodontics	Potential continued root development	Variable biological response	Long-term comparative studies
Single-visit RCT	Fewer appointments	Early postoperative pain may be more frequent	Standardized pain and healing outcomes
Conventional RCT or apexification	Established options for appropriate indications	May not preserve pulp vitality or promote further root development	Comparative effectiveness studies

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