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Deep Margin Elevation Versus Conventional Subgingival Restoration and Surgical Crown Lengthening in Posterior Teeth: A Systematic Review

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Abstract

Deep margin elevation (DME) relocates deep subgingival restorative margins coronally using resin composite. Its periodontal and restorative outcomes must be examined against clearly defined alternatives. This study aims to systematically review clinical comparative evidence for DME versus conventional restorative management without margin elevation or surgical crown lengthening in adults with posterior teeth requiring management of deep proximal/subgingival margins. The review was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD420251242075). PubMed/MEDLINE, Google Scholar, ClinicalTrials.gov, reference lists, and supplementary scholarly sources were searched through June 2026; reports were reassessed using available sources through October 2026. Eligible clinical comparisons were classified as DME versus non-DME restorative controls (subgroup A) or DME versus surgical crown lengthening (subgroup B). The Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool was used for nonrandomized studies and the Cochrane Risk-of-Bias Tool for Randomized Trials (RoB 2) was used for the randomized trial for the randomized trial. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was applied by outcome and comparison. Clinical and methodological heterogeneity precluded meta-analysis. Seven independent clinical studies reported in eight publications contributed to the narrative synthesis: six nonrandomized comparative studies (seven reports, including the linked Hausdörfer 2024 and 2025 cohort reports) and one randomized trial comparing DME with surgical crown lengthening. One nonrandomized study used a natural-root-surface control and was treated as indirect evidence. The randomized trial included 20 proximal cavities; 19 were represented in the reported outcome tables (DME n=10; crown lengthening n=9), with 12-month follow-up. At 12 months, mean clinical attachment level was 0.85 mm with DME and 1.39 mm with crown lengthening (p=0.010), and probing depth was 2.10 versus 2.61 mm (p=0.033). At 12 months, bleeding on probing (BOP) was absent in both groups; the between-group difference in amount of bone loss was not statistically significant, although raw crestal bone-level measurements differed as expected after surgery. Subgroup A findings were heterogeneous and often relied on indirect control conditions. No meta-analysis was performed. Available evidence suggests potentially favorable short-term periodontal outcomes with DME compared with surgical crown lengthening in one small, randomized trial, but certainty is limited by sample size, short follow-up, and risk-of-bias concerns. Observational comparisons remain heterogeneous. Ferrari et al. compared cervical margin relocation with conventional shoulder preparations, but equivalent initial margin depths were not demonstrated; Bertoldi et al. compared DME-treated composite sites with natural root-surface sites and is treated as indirect evidence. Neither long-term superiority nor equivalence has been established; larger, prospectively registered trials with longer follow-up are required.

Categories: Medical Education, Quality Improvement, Dentistry
Keywords: cervical margin relocation, crown lengthening, deep margin elevation, periodontal parameters, posterior teeth, subgingival margin, systematic review

Introduction And Background

Posterior teeth with deep proximal or subgingival margins present significant challenges during restorative treatment. Achieving adequate rubber dam isolation, preventing contamination by crevicular fluid, and ensuring reliable adhesive bonding and marginal integrity can be difficult in these situations [1-4]. Conventional management approaches include direct subgingival restoration and surgical crown lengthening. Direct subgingival restoration may be associated with compromised bonding and marginal leakage, whereas surgical crown lengthening involves apical repositioning of the alveolar crest and may result in surgical morbidity, postoperative healing requirements, and alterations in periodontal architecture [5-7]. These challenges have encouraged the development of conservative restorative approaches that facilitate the management of deep margins while maintaining periodontal health.

Deep margin elevation (DME), also referred to as cervical margin relocation (CMR), cervical margin elevation

(CME), composite margin relocation, or proximal box elevation (PBE), involves placing resin-based composite at the base of a deep proximal preparation to relocate the restorative margin to a more coronal and accessible position [8-10]. The technique aims to facilitate restorative procedures by improving access and isolation while potentially avoiding surgical crown lengthening in appropriately selected cases. In vitro studies have investigated marginal adaptation at the DME interface [11-13], while narrative reviews have discussed its biological rationale, clinical applications, and potential limitations [14-16]. Nevertheless, the periodontal implications of DME remain an important consideration, particularly when restorative margins are positioned close to the supracrestal tissue attachment.

Although previous reviews have examined DME and its clinical implications, the available evidence requires further evaluation in relation to specific clinical comparators. A systematic review by Priya et al. [17] addressed a related research question using broader inclusion criteria. However, the extent to which published clinical studies directly compare DME with conventional subgingival restoration at the original margin depth or surgical crown lengthening remains an important evidence gap. Studies comparing DME-treated surfaces with supragingival, equigingival, or non-DME control surfaces may provide useful contextual information regarding periodontal and restorative outcomes, but they do not necessarily establish its comparative effectiveness against the two specific clinical alternatives.

Therefore, this systematic review, registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD420251242075), aimed to evaluate the available evidence comparing DME with conventional subgingival restoration at the original margin depth and surgical crown lengthening in adults requiring restorative treatment of posterior teeth. The review specifically sought to assess periodontal and restorative outcomes associated with these interventions, evaluate the methodological quality and risk of bias of the included studies, and determine the certainty and comparability of the available evidence.

Review

Methods

Review Question and Objectives

Among adults aged at least 18 years requiring restoration of posterior teeth with deep proximal or subgingival margins, how does DME using a resin-composite material compare with conventional subgingival restoration without DME (A) or surgical crown lengthening with subsequent restoration (B) for marginal adaptation, sensitivity, satisfaction, periodontal health, restoration survival, and complications? The two comparison groups were kept distinct throughout extraction, bias assessment, certainty assessment, and synthesis.

Protocol, Eligibility, and Outcomes

The underlying protocol registration is CRD420251242075. Eligible studies comprised randomized or controlled clinical trials and prospective or retrospective clinical comparative cohorts in adult premolars/molars. Case series, single-arm studies, in vitro reports, and comparisons in which every arm received a DME variant were excluded. Cross-study clinical comparators were classified by actual intervention rather than by a broad “non-DME” label. Table *1* presents the prespecified Population, Intervention, Comparator, Outcomes, and Study Design (PICOS) framework used to guide this systematic review.

Domain	Definition
Population (P)	Adults ≥18 years, posterior teeth with deep proximal/subgingival restorative margins
Intervention (I)	Composite-resin DME/CMR/CME/PBE
Comparator A (C)	Restoration without margin elevation, ideally at the corresponding original deep level; other non-DME tooth/site controls assessed for indirectness
Comparator B (C)	Surgical crown lengthening followed by definitive restoration
Primary outcomes (O)	Marginal adaptation, postoperative sensitivity, patient satisfaction, esthetics
Secondary outcomes (O)	PPD, CAL, BOP, GI, plaque, survival, failure, secondary caries and other complications
Study designs	RCTs, controlled trials, prospective or retrospective comparative clinical cohorts

TABLE 1: Prespecified PICO framework

DME: deep margin elevation; CME: cervical margin elevation; CMR: cervical margin relocation; PBE: proximal box elevation; PPD: probing pocket depth; CAL: clinical attachment level; BOP: bleeding on probing; GI: gingival index; PI: plaque index; RCT: randomized controlled trial

The systematic review was reported with reference to the PRISMA 2020 reporting guideline [18].

Information Sources and Historical Identification

Searches conducted through June 2026 identified 47 records from PubMed/MEDLINE, six additional records from Google Scholar, one from ClinicalTrials.gov, and three from reference lists. Semantic Scholar, Europe PMC, and publisher websites were also searched, but source-specific yields were not recorded separately. Searches of Embase, Scopus, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL), World Health Organization International Clinical Trials Registry Platform (WHO ICTRP), and ProQuest were not undertaken because institutional access was unavailable. The four quantified sources sum to a documented subtotal of 57 records; because the original search log was unavailable, this cannot be verified as the total across all sources. The detailed PubMed/MEDLINE search strategy and supplementary search information are provided in Appendix A.

The historical report-level count was checked against the report-level references and screening/retrieval information retained in the available review files. A report was counted as individually traceable only when its identity could be linked to a retained reference and its place in the current report-level reconciliation could be established. This assessment did not recreate the original database search or screening decisions: the original search export, deduplication file, and complete record-level screening log were not available. Eleven of the 15 historical report-level records could be identified from the retained register; four could not be individually identified or linked to a verifiable stage-specific decision. The four unresolved records were therefore kept as untraceable historical records and were not assigned inferred titles, retrieval outcomes, or full-text exclusion reasons. The later-identified Hausdörfer follow-up [19] was treated as a linked report from the cohort [20], not as an additional independent study.

Report Retrieval and Study Linkage

For this revision, public scholarly searches were made for the full texts of the five reports previously listed as background/unassessed, including searches of PubMed/PMC, publisher pages, institutional repositories, and publicly accessible full-text copies. Full texts were located and assessed for Bresser et al. [21], Gözetici-Çil et al. [22], Ghezzi et al. [23], Ismail et al. [24], and Bertoldi et al. [25]. Bresser et al., Gözetici-Çil et al., Ghezzi et al., and Ismail et al. did not meet the registered comparator/design criteria and are now classified as full-text exclusions. Bertoldi et al. [25] reported a within-tooth comparison of DME-treated composite sites with natural root-surface sites; it was added to subgroup A as indirect evidence, not as a direct comparison with conventional subgingival restoration. The Ferrari accepted manuscript [26] was available through an institutional repository; Muscholl et al. [27] was available as an open-access full text; Aziz et al. [28] was reviewed using an author-uploaded full-text copy and publisher record; and the Hausdörfer 2025 report [19] was available as an open-access follow-up of the cohort reported in 2024 [20]. The Farouk et al. [29] full article text, including its outcome tables, was reviewed from a publicly accessible copy and checked against the publisher abstract; the publisher page itself indicates subscription access. No interlibrary-loan request or direct author-contact request was made because public full-text copies were located for the reports reassessed here. These steps describe public-source retrieval only and should not be represented as

institutional-library or author-contact attempts.

The historical screening summary documents a subtotal of 57 records from four sources with quantified yields (PubMed/MEDLINE (n=47), Google Scholar (n=6), ClinicalTrials.gov (n=1), and reference lists (n=3)), followed by five duplicates, 52 title-and-abstract screening decisions, 37 initial exclusions, and 15 records progressing to report-level resolution. Semantic Scholar, Europe PMC, and publisher websites were also consulted, but source-specific yields were not recorded; their contribution cannot be assumed to be zero. The original search log and deduplication records were unavailable for independent verification, so 57 remains a documented subtotal, not a verified all-source total. Eleven reports were identifiable in the retained report-level register: two originally included reports [20,30], four priority reports [26-29], and five reports previously classed as background/unassessed [21-25]. The five previously unassessed reports were retrieved and reassessed for this revision: four were excluded after full-text assessment [21-24], and Bertoldi et al. [25] was added as indirect subgroup-A evidence. Four records in the historical total of 15 are not individually traceable in the retained register; their exact report identities and stage-specific outcomes cannot be reconstructed, so they are not assigned invented exclusion reasons. The Hausdörfer follow-up [19] was identified later and is linked to the same cohort as [20]. The synthesis therefore includes seven independent studies represented by eight reports.

Study Selection, Risk of Bias, and Synthesis

The review protocol specified clinical comparative designs and two comparison groups. For this revision, full-text eligibility was rechecked against the registered PICO; linked reports from the same cohort were combined at the study level. Reports with only single-arm DME outcomes or comparisons among DME/material variants were excluded. Natural-root-surface or healthy-tooth controls were retained only as indirect evidence and are not interpreted as conventional subgingival restorative controls.

The prespecified comparison groups were retained: subgroup A compared DME with restorative control conditions without margin elevation, while subgroup B compared DME with surgical crown lengthening. Ferrari et al. [26] compared CMR with conventional shoulder preparations and is retained as comparative evidence for subgroup A; however, equivalent initial margin depths were not demonstrated. Bertoldi et al. [25] compared DME-treated composite sites with natural root-surface sites within the same tooth and is classified as indirect evidence. Other subgroup-A controls included opposing supra-/equigingival surfaces, a healthy control tooth, or non-DME crowns; their indirectness is considered in synthesis and Grading of Recommendations Assessment, Development, and Evaluation (GRADE). The Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) was applied to six nonrandomized subgroup-A studies. The Cochrane Risk-of-Bias Tool for Randomized Trials (RoB 2) was applied separately to Farouk et al. [29], the randomized subgroup-B trial. The narrative synthesis was conducted in accordance with the Synthesis Without Meta-analysis (SWiM) reporting guideline [31].

Certainty of Evidence

GRADE [32] was applied by outcome within each comparison group. Observational studies began at low certainty, whereas randomized evidence began at high certainty. Certainty was downgraded as indicated by risk of bias, comparator indirectness, inconsistency, imprecision, and follow-up duration. Non-significant findings were not interpreted as evidence of treatment equivalence.

Results

Study Identification and Record Accounting

Table *2* summarizes the historical study identification and screening records, together with the retrospective reconciliation and full-text reassessment undertaken for the present revision. The historical screening totals were 57 documented records from sources with recorded yields, five duplicates removed, 52 screened, 37 excluded at title-and-abstract screening, and 15 advanced to report-level resolution. Retrospective reconciliation of the retained report-level register identified 11 of these 15 records; four (26.7%) could not be individually traced. The 11 identifiable reports comprised two originally included reports [20,30], four priority reports [26-29], and five reports previously classed as background/unassessed [21-25]. This identity reconciliation does not establish that the original screening pathway for each identifiable report was fully documented. Five previously unassessed reports were retrieved and reassessed: four were excluded after full-text assessment [21-24], while Bertoldi et al. [25] was added as indirect evidence. The Hausdörfer et al. (2025) follow-up [19] is linked to the 2024 cohort [20], not a separate study. The supplementary source contribution to the documented 57-record subtotal remains unverifiable without the original search log.

Phase	Number	Explanation/source
PubMed/MEDLINE	47	Historical reported count
Google Scholar		

(additional)	6	Historical reported count
ClinicalTrials.gov	1	Historical reported count
Reference lists	3	Historical reported count
Semantic Scholar, Europe PMC, publisher websites	Not separately recorded	Do not interpret as zero. Check the original search log and deduplication records; unique contributions remain unverified.
Total historical identification	57 documented records	Sum of the four sources with recorded counts only; supplementary-source contribution could not be verified because separate counts/search-log entries were not available.
Duplicates removed	5	Historical reported count
Titles/abstracts screened	52	57-5
Excluded at title/abstract stage	37	Historical reported count
Advanced to report-level resolution	15	52-37
Identifiable reports within historical report-level count	11	11 reports identifiable in the retained report-level register: 2 originally included reports[20,30] + 4 priority reports [26-29] + 5 previously background/unassessed reports[21-25]. This is a retrospective identity reconciliation, not proof that all 11 had a fully documented original screening pathway.
Additional linked follow-up identified later	1	Hausdörfer 2025 [19], linked to the 2024 cohort[20]; not a separate study
Previously unassessed reports retrieved and reassessed	5	Publicly accessible full texts/copies located for Bresser[21], Gözetici-Çil [22], Ghezzi [23], Ismail [24], and Bertoldi [25]
Full-text exclusions after reassessment	4	Bresser [21], Gözetici-Çil [22], Ghezzi [23], and Ismail [24]
Additional indirect report included	1	Bertoldi [25], DME-treated composite sites versus natural root-surface sites; classified as indirect subgroup-A evidence
Untraceable records within historical report-level count	4	Four records in the historical total of 15 are not individually traceable in retained records; their identities and stage-specific outcomes cannot be reconstructed
Independent clinical studies in narrative synthesis	7	Six nonrandomized studies in subgroup A plus one randomized trial in subgroup B
Reports contributing to narrative synthesis	8	Seven subgroup A reports from six studies plus Farouk[29] in subgroup B
Potentially eligible direct-comparison report assessed	1	Farouk et al. [29]; full article text and outcome tables reviewed; included in subgroup B
Studies in meta-analysis	0	Heterogeneity and lack of compatible effect/variance data

TABLE 2: Study identification, screening, and report accounting

The historical identification, screening, and retrospective report-level reconciliation process is illustrated in Figure *1*.

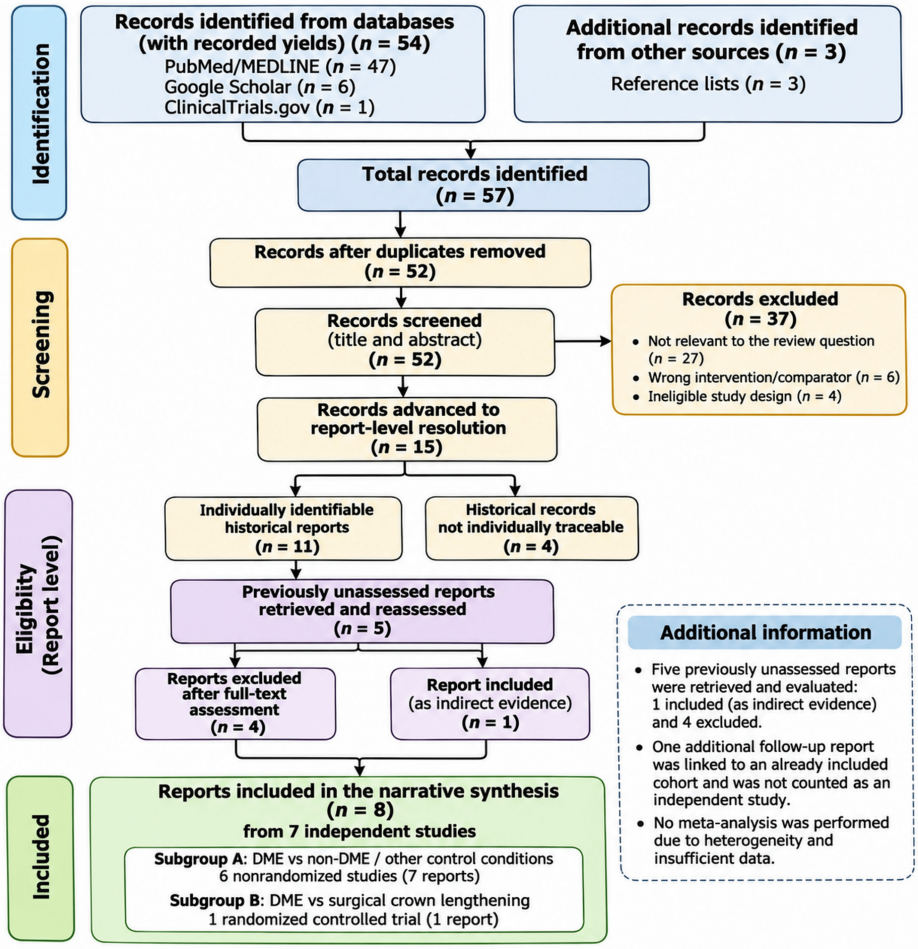


FIGURE 1: PRISMA 2020-informed flow diagram of study identification, screening, and retrospective report-level reconciliation

DME: deep margin elevation

The figure was generated using ChatGPT (OpenAI, San Francisco, CA, USA).

Characteristics of Included Studies

Table 3 summarizes the characteristics and principal findings of the seven independent clinical studies represented by eight reports included in the narrative synthesis. The studies are presented according to their design, sample characteristics, follow-up duration, actual comparator conditions, and clinically relevant outcomes. The comparator classification distinguishes subgroup A, which includes restorative or non-DME control conditions, from subgroup B, which directly compares DME with surgical crown lengthening. Studies using healthy teeth, natural root surfaces, or opposing non-DME sites as controls are identified as indirect evidence rather than direct comparisons with conventional subgingival restoration.

Study/reference	Design; sample and follow-up	Actual comparator and synthesis classification	Main relevant results
Ferrari et al. 2018 [26]	Controlled within-tooth study; 35 posterior teeth; 12 months	CMR vs conventional shoulder preparations; subgroup A, eligible comparative control, but equivalent initial margin depths were not demonstrated	BOP 53.0% versus 31.5%; abstract reports p=0.10, but the narrative describes the difference as statistically significant. The discrepancy remains unresolved; not treated as statistically significant.
Muscholl et al. 2022 [27]	Retrospective comparative cohort; 63 patients; restoration age 2.70 ± 1.90 years	DME tooth vs a sound control tooth; A, indirect healthy-tooth comparator	No significant differences in BOP, GBI or plaque; CAL higher in treated teeth (p=0.027); test-tooth BOP adjusted OR 1.633, 95% CI 0.731–3.651
Hausdörfer et al. 2024 [20] + 2025 [19]	Prospective within-tooth controlled; 68 patients/77 restorations baseline; 55/62 at year 1, 51/57 at year 2	DME proximal margin vs opposite supra-/equigingival proximal margin; A, one cohort	Year 1 BOP 73.8% vs 44.3%, p_adj=0.005. Year 2 between-site BOP p_adj=0.110 and PD p_adj=0.015; not two independent studies
El-Ma'aita et al. 2024 [30]	Retrospective clinical within-tooth; 25 patients, 28 restorations; mean 25.4 months	DME vs opposite non-DME site of same tooth; A, indirect	GI p=0.35; PPD 2.8 vs 2.6 mm, p=0.34; reported 96.4% restoration survival
Aziz et al. 2025 [28]	Retrospective multicenter comparative cohort; 380 patients, 426 lithium disilicate crowns; 10 years	153 DME vs 273 without DME crowns; A, comparator groups may differ in indication/depth	Ten-year survival 95.8% vs 94.7%; success 94.1% vs 93.0%; periodontal measurements not significantly different (reported P>0.05)
Farouk et al. 2024 [29]	Randomized controlled clinical trial; 20 cavities enrolled; outcome tables DME n=10, CL n=9; 12 months	DME versus surgical crown lengthening; subgroup B, direct registered comparison	At 12 months, CAL 0.85 vs 1.39 mm (p=0.010); PD 2.10 vs 2.61 mm (p=0.033); BOP 0% in both groups; no secondary caries. Raw crestal bone-level measurements differed by treatment, but the between-group difference in amount of bone loss was not significant.
Bertoldi et al. 2020 [25]	Prospective clinical/histologic within-tooth comparison; 29 subjects completed; three months	DME-treated composite site vs natural root-surface site in same tooth; subgroup A, indirect comparator, not conventional subgingival restoration	PD was greater at composite-adjacent sites than natural-root sites at baseline (2.57 vs 1.95 mm) and at 3 months (2.21 vs 1.66 mm); histologic inflammation did not differ significantly (p=0.36). Highly selected, plaque-controlled cohort; short follow-up.

TABLE 3: Characteristics of seven independent clinical studies (eight reports)

BOP: bleeding on probing; CAL: clinical attachment level; CMR: cervical margin relocation; CL: crown lengthening; DME: deep margin elevation; GBI: gingival bleeding index; GI: gingival index; OR: odds ratio; PD: probing depth; PPD: probing pocket depth; 95% CI: 95% confidence interval

Hausdörfer 2024 [20] and its 2025 follow-up [19] represent a single participant cohort. Ferrari et al. [26] reported bleeding on probing (BOP) in 53.0% of CMR sites and 31.5% of comparison sites; the abstract reported p=0.10, while the narrative described the difference as statistically significant. This value is used for the synthesis, which does not classify the observed difference as statistically significant.

Additional Comparative Reports

The additional comparative reports were assessed against the registered PICO. Ferrari et al. [26], Muscholl et al. [27], Aziz et al. [28], Farouk et al. [29], and the linked Hausdörfer et al. follow-up [19] were reviewed using available full-text sources. Bertoldi et al. [25] was newly included as indirect evidence after full-text assessment. The linked Hausdörfer et al. reports represent one cohort and are counted as one study. Farouk

et al. [26] was eligible for subgroup B and is included in the narrative synthesis, with RoB 2 and GRADE judgments reported separately from the nonrandomized evidence (Table 4).

Report	Source/status of report	Main finding/interpretation
Ferrari et al. 2018 [26]	PubMed/publisher abstract and accepted manuscript located through an institutional repository	CMR vs conventional shoulder preparation; BOP 53.0% vs 31.5%; abstract reports p=0.10 while narrative calls the difference significant; discrepancy unresolved.
Farouk et al. 2024 [29]	Publisher abstract plus publicly accessible full-article copy with outcome tables reviewed; publisher page itself is subscription-only	Direct DME-versus-surgical-crown-lengthening RCT; outcome tables confirm CAL, PD, BOP, CBL and secondary-caries results; raw CBL difference distinguished from amount of bone loss
Muscholl et al. 2022 [27]	Open-access full text in PubMed Central (PMC11734308); CC BY publication	Included as indirect subgroup-A evidence; control was a sound tooth, not a conventional subgingival restoration
Aziz et al. 2025 [28]	Publisher record/abstract and author-uploaded full-text copy located through ResearchGate	Retrospective 10-year DME vs non-DME crown cohort; 426 crowns in 380 patients; survival 95.8% vs 94.7%; periodontal outcomes not significantly different
Hausdörfer et al. 2025 [19]	Open-access full text	Two-year follow-up linked to Hausdörfer 2024 [23]; same cohort, not a separate study
Bertoldi et al. 2020 [25]	Author-accepted manuscript located in University of Modena institutional repository	Included as indirect subgroup-A evidence: 29 subjects; DME-composite sites compared with natural-root-surface sites; no significant histologic inflammation difference (p=0.36)

TABLE 4: Additional comparative reports and retrieval status

BOP: bleeding on probing; CAL: clinical attachment level; CBL: crestal bone level; CC BY: Creative Commons Attribution License; CMR: cervical margin relocation; DME: deep margin elevation; PD: probing depth; PICO: Population, Intervention, Comparator, and Outcomes; RCT: randomized controlled trial

Excluded or Background Records

Four reports in Table 5 were excluded after full-text assessment because they did not meet the registered comparator/design criteria. Bertoldi et al. [25] was moved to the included-study characteristics and synthesis as indirect evidence. These decisions are distinct from Farouk et al. [29], which directly met subgroup B eligibility.

Report	Information available in original register	Reason/status	Full text assessed in this revision
Bresser et al. 2019 [21]	Full text located through University of Groningen research repository/public PDF copy	Full-text assessed; single-arm DME cohort (197 restorations in 120 patients) with no eligible non-DME or surgical-crown-lengthening comparison; excluded from comparative synthesis.	Yes
Gözetici-Çil et al. 2024 [22]	Full text located in PubMed Central/publicly accessible PDF copy	Full-text assessed; prospective single-arm PBE cohort (80 restorations) without a non-DME or surgical-crown-lengthening comparator; excluded.	Yes
Ghezzi et al. 2019 [23]	PubMed abstract and publicly accessible full-text copy located	Full-text assessed; 15-patient case series compared three CMR approaches, all involving CMR, with no eligible non-DME or surgical-crown-lengthening control; excluded.	Yes
Ismail et al. 2024 [24]	PubMed abstract and publisher-hosted full-text PDF located	Full-text assessed; randomized comparison of four base materials in subgingival open-sandwich restorations, not DME versus no-DME conventional management or surgical crown lengthening; excluded.	Yes
Bertoldi et al. 2020 [25]	Author-accepted manuscript located in University of Modena institutional repository	Full-text assessed and included as indirect subgroup-A evidence: within-tooth DME-composite sites versus natural-root-surface sites; comparator is not a conventional subgingival restoration.	Yes - included as indirect evidence

TABLE 5: Full-text excluded reports and one report reassigned to indirect evidence

CMR: cervical margin relocation; DME: deep margin elevation; PBE: proximal box elevation

Risk of Bias

Table 6 presents the overall risk-of-bias judgements for the seven independent clinical studies included in the narrative synthesis. Risk of bias was assessed using the ROBINS-I tool [33] for the six nonrandomized subgroup-A studies. The revised RoB 2 [34] was applied separately to Farouk et al. [29], the randomized subgroup-B trial. The overall judgements reflect methodological limitations such as confounding, participant selection, differences in baseline clinical conditions, missing data, outcome measurement, and selective reporting. Serious risk-of-bias concerns were identified in several nonrandomized studies, whereas moderate concerns were observed in others. The randomized trial was judged to have some concerns, particularly regarding trial registration and the small, analyzed sample. These assessments informed the interpretation of the clinical findings and the certainty of evidence.

Study	Tool/domain judgement	Overall and rationale
Ferrari et al. 2018 [26]	ROBINS-I; serious baseline-site confounding and internally discordant BOP p-value reporting	SERIOUS. Baseline site differences and p-value reporting discrepancy
Muscholl et al. 2022 [27]	ROBINS-I; confounding serious; participant selection moderate; measurement moderate	SERIOUS. Restored deep-margin sites were compared with healthy control teeth
Hausdörfer et al. 2024/2025 [20,19]	ROBINS-I; confounding moderate; year-2 attrition moderate; measurement low	MODERATE. Within-tooth comparison with asymmetric baseline defect sites
El-Ma'aita et al. 2024 [30]	ROBINS-I; confounding moderate; selection moderate; examiner blinding concerns	MODERATE. Retrospective study, nonequivalent margin positions and outcome assessment
Aziz et al. 2025 [28]	ROBINS-I; confounding serious; potential selection/reconstruction differences	SERIOUS. Nonrandom treatment indication and possible baseline differences
Bertoldi et al. 2020 [25]	ROBINS-I; selected compliant/plaque-controlled cohort; 14/43 enrolled patients excluded during follow-up; within-tooth comparator and short follow-up	SERIOUS. Attrition and selection concerns; baseline PD differed between composite-adjacent and natural-root-surface sites; three-month follow-up limits inference.

TABLE 6: Risk-of-bias judgments by independent study

ROBINS-I: Risk Of Bias In Non-randomized Studies of Interventions; RoB 2: revised Cochrane Risk-of-Bias tool for randomized trials; PD: probing depth

Table 7 provides the domain-specific ROBINS-I assessments for the six nonrandomized studies included in subgroup A. The studies were evaluated across seven domains: bias due to confounding, participant selection, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. Each domain was judged according to the methodological limitations identified in the respective study. Confounding, particularly differences in baseline defect characteristics and treatment indications, was an important concern across several studies. The overall risk-of-bias judgement was determined by considering the domain-level assessments rather than relying on any single methodological limitation.

Independent study	Conf.	Selection	Classify	Deviat.	Missing	Measure	Reporting	Overall
Ferrari et al. 2018	Serious	Moderate	Low	Low	Moderate	Moderate	Serious	Serious
Muscholl et al. 2022	Serious	Moderate	Low	Low	Low	Moderate	Moderate	Serious
Hausdörfer et al. 2024/25	Moderate	Low	Low	Low	Moderate	Low	Low	Moderate
El-Ma'aita et al. 2024	Moderate	Moderate	Low	Low	Low	Moderate	Low	Moderate
Aziz et al. 2025	Serious	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Serious
Bertoldi et al. 2020	Serious	Moderate	Low	Low	Serious	Moderate	Moderate	Serious

TABLE 7: ROBINS-I domains for nonrandomized studies

ROBINS-I: Risk Of Bias In Non-randomized Studies of Interventions; Conf.: confounding; Deviat.: deviations from intended interventions; Measure: measurement of outcomes; Reporting: selection of the reported result

Table 8 presents the RoB 2 assessment of the randomized controlled trial by Farouk et al. [29], which directly compared DME with surgical crown lengthening. The assessment considered the reported randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of the reported results. Although random sequence generation, opaque sealed-envelope allocation, and blinding of outcome assessors and the statistician were reported, concerns remained because participants and the operator could not be blinded, the analyzed sample was small, and trial registration occurred after the reported study completion. The overall judgement was classified as some concerns. These methodological limitations were considered when interpreting the trial findings and evaluating the certainty of evidence for subgroup B. The risk-of-bias assessments for the included studies are summarized in Figure

2, which presents the domain-level ROBINS-I judgements for the six nonrandomized studies and the overall RoB 2 judgement for the randomized controlled trial.

Report	Full-text status	Risk-of-bias assessment	Basis	Synthesis status	Next action
Farouk et al. 2024 [29]	Full article text and outcome tables reviewed from a publicly accessible copy; publisher page is subscription-only	RoB 2: some concerns, particularly trial registration/reporting and small sample	Random sequence and opaque-envelope concealment reported; assessors/statistician blinded; no patient/operator blinding; registry first posted after reported study completion. At 12 months, DME vs CL CAL 0.85 vs 1.39 mm (p=0.010), PD 2.10 vs 2.61 mm (p=0.033), BOP 0% in both groups; no secondary caries. Raw CBL levels differ by treatment; amount of bone loss did not differ significantly.	Included in subgroup B narrative synthesis	Full text reviewed; no institutional-library or author-contact request made because a public full-text copy was located

TABLE 8: RoB 2 assessment for the randomized comparison

RoB 2: Cochrane Risk-of-Bias; DME: deep margin elevation; CL: crown lengthening; CAL: clinical attachment level; PD: probing depth; BOP: bleeding on probing; CBL: crestal bone level

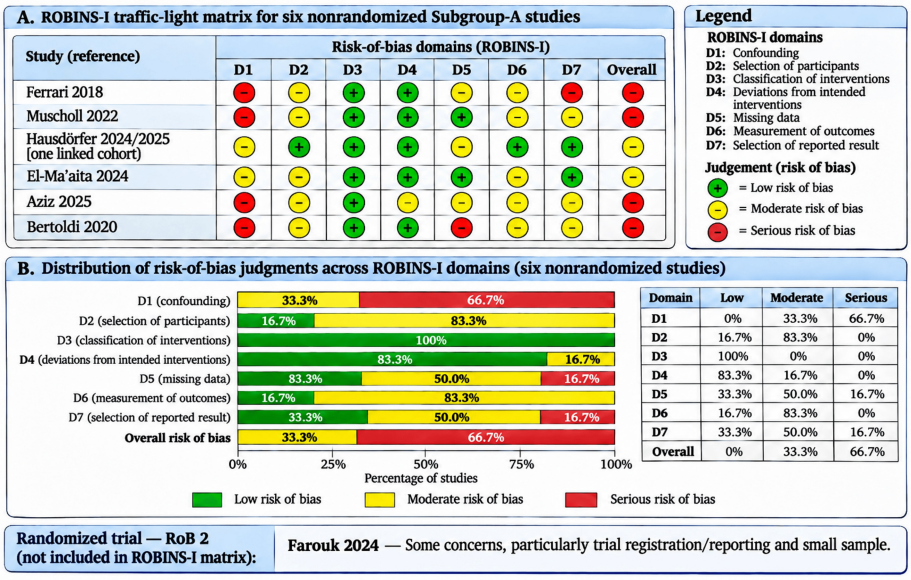


FIGURE 2: Traffic-light plot and distribution of risk-of-bias judgements for included studies assessed using ROBINS-I and RoB 2

Studies included [26,27,19,20,30,28,25]

ROBINS-I: Risk Of Bias In Non-randomized Studies of Interventions; RoB 2: Cochrane Risk-of-Bias

Narrative Synthesis by Registered Comparator

Subgroup A (DME versus non-DME or other site/tooth controls) - gingival inflammation: At 12 months, Hausdörfer et al. reported higher BOP at DME than at opposing control margins (73.8% versus 44.3%; adjusted p=0.005) [20]. At two years, the between-site BOP comparison was no longer statistically significant (adjusted p=0.110), although probing depth (PD) was greater at DME sites (adjusted p=0.015) [19]. Ferrari et al. compared CMR with conventional shoulder preparations and reported BOP of 53.0% versus 31.5%; the abstract reported p=0.10, while the narrative described the difference as statistically significant [26]. This is

relevant comparative evidence for subgroup A, although equivalent initial margin depths were not demonstrated. El-Ma'aita et al. reported no significant gingival-index difference (p=0.35) [30], Muscholl et al. reported no significant BOP or bleeding-index difference [27], Aziz et al. reported no significant periodontal difference between DME and non-DME crown groups [28], and Bertoldi et al. reported no significant histologic inflammation difference between composite-adjacent and natural-root-surface sites (p=0.36) [25]. Bertoldi et al.'s comparator is indirect, and the study's highly selected cohort and short follow-up limit inference. The different control conditions and outcome measures limit cross-study comparison.

PD and clinical attachment: Hausdörfer et al. did not identify a year-1 between-site PD difference but did at year 2 [19,20]. El-Ma'aita et al. reported 2.8 versus 2.6 mm probing pocket depth (PPD) (p=0.34) [30]. Muscholl et al. found a higher CAL in DME teeth (p=0.027), with baseline subgingival defect depth an important confounding explanation [27]. The Aziz et al. cohort provides a longer-term comparison, but its DME indication and margin distribution are not exchangeable between groups [28].

Survival and technical outcomes: Hausdörfer et al., El-Ma'aita et al., and Aziz et al. report favorable survival over divergent time horizons; Aziz et al. specifically reported 95.8% and 94.7% 10-year survival in DME and non-DME groups [28]. These values should not be pooled as if the same outcome or follow-up interval had been measured. Marginal adaptation, postoperative sensitivity, and patient-reported outcomes were inconsistently collected or separately extractable across comparisons.

Subgroup B (DME versus surgical crown lengthening): One randomized trial met the registered subgroup-B comparison. Farouk et al. [29] randomized deep proximal cavities in endodontically treated molars to DME or surgical crown lengthening. Twenty cavities were enrolled; outcome tables reported 10 DME and nine crown-lengthening cases. At 12 months, the mean clinical attachment level (CAL) was 0.85 mm in the DME group and 1.39 mm in the crown-lengthening group (p=0.010); the mean PD was 2.10 versus 2.61 mm (p=0.033). BOP was absent in both groups at 12 months, and no secondary caries was reported. Although raw crestal bone-level measurements differed as expected after surgical bone removal, the between-group comparison of the amount of bone loss was not statistically significant. Interpretation is limited by the small analyzed sample, 12-month follow-up, and trial registration/reporting concerns. The extracted comparator-specific clinical results supporting the qualitative synthesis are presented in Appendix B.

Meta-Analysis Feasibility

No meta-analysis was undertaken. Subgroup A included within-tooth comparisons with opposing margins, a healthy control tooth, natural-root-surface sites, and non-DME crown controls; gingival inflammation was measured as BOP, gingival index (GI), or gingival bleeding index (GBI) across incompatible units and follow-up intervals, and compatible paired variances were usually unavailable. Subgroup B contained one small randomized trial with 12-month follow-up; a single study cannot provide a meaningful pooled estimate or establish long-term effects.

Grade Certainty of Evidence

The outcome-specific certainty of evidence, assessed separately for the two registered comparator groups using the GRADE approach, is summarized in Table *9*. GRADE certainty was assessed separately for each clinically relevant outcome within the two registered comparator groups. In subgroup A, the certainty of evidence was rated very low for gingival inflammation, probing depth/clinical attachment, and 10-year crown survival, primarily due to methodological limitations, confounding, indirect comparator conditions, heterogeneous outcome measures, and imprecision. In subgroup B, the certainty of evidence from the single randomized controlled trial was rated low for clinical attachment level, probing depth, and the combined outcomes of bleeding on probing, crestal bone level, and secondary caries. The main downgrading factors were the small analyzed sample, limited 12-month follow-up, and concerns regarding trial registration/reporting and imprecision. These ratings indicate that the available evidence remains limited and that the findings should be interpreted cautiously. The outcome-specific assessments and corresponding interpretations are presented in Table *9*.

Comparator/outcome	Studies	Principal downgrading factors	Certainty	Interpretation
A - gingival inflammation (BOP/GI/GBI/histology)	Six nonrandomized studies (seven reports; comparator directness varies)	Serious/nonrandom confounding; indirect controls in several studies; Ferrari p-value inconsistency; heterogeneous definitions and follow-up; no pooled precision	Very low	Direction and size of comparative inflammatory effect remain uncertain
A - PD/attachment	Six nonrandomized studies (seven reports; comparator directness varies)	Different outcomes, margin depths, comparator directness, bias and timing; Bertoldi had a selected cohort and short follow-up; insufficient compatible comparative estimates	Very low	Site differences cannot be attributed to DME confidently
A - 10-year crown survival	One [28]	Retrospective indication confounding; unequal DME and non-DME margins	Very low	High survival observed in both arms; equivalence not proven
B - CAL	One RCT, n=19 analyzed	Small sample; 12-month follow-up; concerns about registration/reporting; imprecision	Low	DME group had lower mean CAL at 12 months (0.85 vs 1.39 mm; p=0.010); preliminary finding
B - PD	One RCT, n=19 analyzed	Small sample; 12-month follow-up; concerns about registration/reporting; imprecision	Low	DME group had lower mean PD at 12 months (2.10 vs 2.61 mm; p=0.033); durability uncertain
B - BOP/crestal bone/secondary caries	One RCT, n=19 analyzed	Small sample; limited follow-up; imprecision; raw crestal bone levels differ due to surgery, but amount of bone loss was not significantly different	Low	No between-group BOP difference at 12 months; no significant difference in amount of bone loss; no secondary caries reported

TABLE 9: Outcome-specific GRADE summary, separated by registered comparator

DME: deep margin elevation; BOP: bleeding on probing; CAL: clinical attachment level; GBI: gingival bleeding index; GI: gingival index; GRADE: Grading of Recommendations Assessment, Development and Evaluation; PD: probing depth; RCT: randomized controlled trial

GRADE certainty levels: High, moderate, low, and very low. Very low certainty indicates that the true effect is likely to be substantially different from the estimated effect. Low certainty indicates limited confidence in the estimated effect, with the possibility that the true effect may differ.

Note: Subgroup A represents DME versus non-DME restorative or other site/tooth control conditions, whereas subgroup B represents DME versus surgical crown lengthening followed by restoration. Indirect comparator conditions are identified and considered during certainty assessment.

Discussion

Principal Findings

Seven independent clinical studies contributed to the review: six nonrandomized studies represented by seven reports in subgroup A and one randomized trial in subgroup B. The subgroup-A evidence includes Ferrari et al.'s comparison of CMR with conventional shoulder preparations, although equivalent initial margin depths were not demonstrated, and Bertoldi et al.'s comparison with natural root-surface sites, which is indirect. Other subgroup-A studies also used less directly comparable controls. The subgroup-B trial directly addressed DME versus surgical crown lengthening but was small and followed participants for 12 months.

Clinical Interpretation

DME is a tissue-conserving option for selected posterior teeth. In the one randomized comparison with surgical crown lengthening, DME was associated with lower mean CAL and PD at 12 months, while BOP was absent in both groups and the amount of bone loss did not differ significantly; raw crestal bone-level measurements differed as expected after surgery. These results are preliminary and should not be interpreted as proof of superiority or equivalence. The observational evidence remains limited by treatment-selection bias, baseline anatomical differences, and inconsistent periodontal outcomes.

Strengths and Limitations

Strengths include comparator-specific assessment, separate appraisal of randomized and nonrandomized evidence, linkage of reports from the same cohort, and full-text reassessment of the five reports previously listed as unassessed. Public scholarly searches located full texts/copies for all five; four were excluded after full-text assessment, and Bertoldi et al. was included as indirect evidence. No interlibrary-loan or direct author-contact requests were made because public copies were located. Limitations include unavailable historical search exports and deduplication logs, four of 15 historical report-level records (26.7%) that cannot be individually traced, with no defensible basis for assigning their identities or stage-specific outcomes, non-execution of several planned databases, and unrecorded supplementary-source yields. The Ferrari publication contains conflicting significance wording and p=0.10 in the abstract; the reported table value is retained without classifying the difference as statistically significant. The subgroup-B evidence rests on one small trial with short follow-up and registration/reporting concerns.

Implications for Future Research

Future trials should compare DME with restorations at equivalent initial subgingival margin depths and with surgical crown lengthening, using standardized clinical attachment, probing-depth, inflammation, and restoration-survival measures. Prespecified outcome protocols, prospective trial registration, independent blinded outcome assessment where practicable, reporting of missing observations, and longer follow-up would improve the interpretability of comparative results. Future systematic review updates would also benefit from complete search exports and report-level screening logs.

Conclusions

Seven independent clinical studies represented by eight reports contributed to the narrative synthesis: six nonrandomized studies in subgroup A and one randomized trial in subgroup B. Subgroup A comparators varied; Ferrari et al. compared CMR with conventional shoulder preparations, but equivalent initial margin depths were not demonstrated, while Bertoldi et al. used natural root-surface sites as an indirect control. In the single small randomized trial, DME was associated with lower mean CAL and PD at 12 months than surgical crown lengthening; BOP was absent in both groups, and the amount of bone loss did not differ significantly. These findings remain preliminary, with low certainty for subgroup B and very-low certainty for subgroup A; neither long-term superiority nor equivalence is established.

Appendices

Appendix A

Literature Search Strategy

The PubMed/MEDLINE strategy used the following title/abstract terms without a date or language restriction: ("deep margin elevation"[tiab] OR "cervical margin relocation"[tiab] OR "cervical margin elevation"[tiab] OR "composite margin relocation"[tiab] OR "proximal box elevation"[tiab]) AND ("posterior"[tiab] OR "premolar"[tiab] OR "molar"[tiab] OR "periodontal"[tiab] OR "survival"[tiab] OR "adaptation"[tiab]).

The documented search through June 2026 identified 47 PubMed records, six additional Google Scholar records, one ClinicalTrials.gov record, and three records from reference lists. Semantic Scholar, Europe PMC, and publisher sites were also consulted, with their counts not recorded separately. The review was registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD420251242075).

Appendix B

Comparator-Specific Clinical Results Used for Qualitative Synthesis

Report	Group	Follow-up	Extracted result	Caution
Ferrari 2018 [26]	A, conventional shoulder-preparation comparator; initial margin-depth matching unclear	12 months	BOP 53.0% DME vs 31.5% shoulder	The abstract reports p=0.10, conflicting with narrative significance wording; do not classify as statistically significant pending clarification.
Muscholl 2022 [27]	A, indirect	Mean 2.7 years	CAL adjusted +0.421 mm (95% CI 0.057 to 0.785; p=0.027)	No significant BOP/GBI/PCR increase compared with sound tooth
Hausdörfer 2024 [20]	A, indirect	12 months	BOP 73.8% vs 44.3% (p-adj=0.005)	Within-tooth difference; linked to 2025 report
Hausdörfer 2025 [19]	A, linked	24 months	BOP between-side p-adj=0.110; PD p-adj=0.015	Same cohort as preceding row, not another study
El-Ma'aita 2024 [30]	A, indirect	Mean 25.4 months	PPD 2.8 vs 2.6 mm (p=0.34); GI p=0.35	Cross-sectional within-tooth comparison
Aziz 2025 [28]	A, nonrandom	10 years	Survival 95.8% DME vs 94.7% non-DME	Indication bias; lack of significance is not equivalence
Farouk 2024 [29]	B, direct	12 months	CAL 0.85 vs 1.39 mm (p=0.010); PD 2.10 vs 2.61 mm (p=0.033); BOP 0% in both groups at 12 months	One small RCT; 20 enrolled, 19 reported in outcome tables; registration/reporting concerns; no proof of long-term superiority
Bertoldi 2020 [25]	A, indirect natural-root-surface comparator	Three months	PD 2.57 vs 1.95 mm at baseline; 2.21 vs 1.66 mm at three months; histologic inflammation p=0.36	Natural root surface is not a conventional restoration; selected plaque-controlled cohort, substantial post-enrolment exclusions, short follow-up

TABLE 10: Comparator-specific clinical results used for the qualitative synthesis

DME: deep margin elevation; BOP: bleeding on probing; CAL: clinical attachment level; CI: confidence interval; GBI: gingival bleeding index; PCR: plaque control record; PD: probing depth; PPD: probing pocket depth; GI: gingival index; RCT: randomized controlled trial

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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