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Deep Margin Elevation: Integrating Periodontal Biology, Adhesive Science, And Clinical Outcomes—A Critical Narrative Synthesis

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Abstract
Deep margin elevation (DME) has emerged as a conservative restorative strategy for teeth presenting with deep proximal margins that extend below the gingival margin. By relocating the restorative interface coronally, the technique facilitates isolation, enhances visualization, and improves adhesive control in areas that are otherwise clinically challenging.
This narrative review critically appraises the biological rationale, clinical indications, material considerations, and reported outcomes associated with DME. A comprehensive literature exploration of PubMed, Scopus, and the Cochrane Library was undertaken up to February 2026 using focused keyword combinations related to deep margin elevation and proximal box relocation. After applying predefined inclusion parameters, 59 publications encompassing laboratory investigations, clinical studies, and relevant reviews were synthesized.
Current evidence indicates that, in carefully selected cases, DME may provide a minimally invasive alternative to surgical crown lengthening while maintaining periodontal stability. Composite resins remain the most extensively investigated materials for margin relocation, largely due to their adhesive compatibility and mechanical durability, although variations in viscosity and filler composition may influence performance.
Despite encouraging short- to medium-term findings, the heterogeneity of study designs limits definitive conclusions. Well-designed randomized clinical trials with long-term follow-up are required to establish standardized protocols and clarify material selection. Appropriate case assessment and strict adherence to procedural principles remain fundamental to achieving predictable biological and functional outcomes.
Keywords: *deep margin elevation; proximal box relocation; subgingival margins; adhesive restorative techniques; adhesive dentistry; adhesive systems; dental adhesives; resin-based adhesives; bonding agents; adhesive protocols*

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I. Introduction

Contemporary dentistry is grounded in two central principles: biomimetics and the preservation of healthy tooth structure.[1] In everyday practice; however, these ideals are put to the test—especially when dealing with carious lesions that extend below the gumline. [2]

Subgingival finishing lines complicate rubber dam isolation, matrix placement, and cervical adaptation, increasing the risk of marginal defects. These difficulties extend beyond the operative phase: deep margins can hinder impression taking, bonding, and luting—especially for indirect restorations. Poorly managed cervical interfaces favour plaque retention, gingival inflammation, and potential violation of the supracrestal tissue attachment, ultimately jeopardizing restoration longevity. [3-5]

Traditionally, surgical crown lengthening or orthodontic extrusion has been used to reposition deep margins coronally.[6-8] Surgical crown lengthening may reduce periodontal support and compromise esthetics, particularly anteriorly. Orthodontic extrusion preserves tissue architecture but requires extended treatment time and strong patient compliance. Together, these limitations highlight the need for a less invasive alternative.[9,10]

Deep Margin Elevation (DME) was introduced to meet this need. Instead of altering periodontal tissues, the technique relocates the cervical margin coronally using an adhesively bonded composite buildup.[11-12] First described by Dietschi and Spreafico in 1998 for indirect restorations, its application has since expanded to direct procedures and digital workflows.[13,14] By improving access, isolation, and finishing control, DME may reduce both technical complexity and biological risk.[15,16]

Despite its growing use, the evidence remains inconsistent. Debate persists regarding material selection, bonding strategies, operative protocols, and long-term outcomes. High-quality randomized trials—particularly those assessing periodontal response—are scarce, and standardized clinical guidelines are lacking.[17]

This review synthesizes current evidence on DME, focusing on indications, material choice, operative steps, and biological and mechanical performance. Given the variability and occasional contradictions in existing recommendations, a critical appraisal is necessary to clarify trends, expose knowledge gaps, and support the development of more reliable clinical protocols grounded in long-term data.

II. Methodology

This narrative review followed a structured search strategy to gather evidence on Deep Margin Elevation (DME) and related margin management approaches. A modified PICO framework guided the review:[18]

The ***population*** included posterior teeth with subgingival cervical margins.

The ***intervention*** was adhesive margin relocation, ***compared*** with surgical crown lengthening and orthodontic extrusion.

Outcomes of interest were restoration longevity, periodontal response, marginal integrity, and overall durability.

Electronic searches were conducted in PubMed, Scopus, and the Cochrane Library for studies published between January 1998 and February 2026. Keywords related to DME, proximal box elevation, subgingival margin management, and adhesive restorations were combined using database-specific Boolean strategies. Web of Science was excluded due to overlap with Scopus, which offered broader coverage of dental research.

Eligible studies directly addressed DME and its clinical application, including indications, materials, techniques, limitations, and outcomes. Systematic reviews, clinical trials, observational studies, case reports, laboratory investigations, and finite element analyses were included. Only English-language publications were considered.

Study selection occurred in two stages: title and abstract screening followed by full-text assessment. Three reviewers independently evaluated articles, resolving disagreements through discussion. The process followed PRISMA guidelines.

In total, 57 studies met the inclusion criteria: 11 clinical investigations, 23 in vitro studies, 20 reviews, two finite element analyses, and one technique-focused article. Many clinical studies involved small samples, and only two extended beyond five years. Non-randomized designs were common, increasing the risk of bias.

Laboratory and simulation studies offered insight into material behaviour and stress distribution but cannot fully replicate the biological complexity of the oral environment. These limitations were considered during critical appraisal and synthesis of findings.

Development and Conceptual Progression of Deep Margin Elevation

As early as 1977, McLean andWilson proposed the placement of a glass ionomer cement layer at the cervical margin of Class II restorations with subgingival margins, followed by overlaying this layer with composite resin. This method, widely known as the “open-sandwich technique”, demonstrated limited success due to the dissolution and mechanical degradation of conventional glassionomer when exposed to the oral environment.[19, 20]

To address these limitations, resin-modified glass ionomer cement was introduced, offering improved mechanical properties, easier handling and significantly higher success rates compared to traditional glass ionomer.[21-24]

First formally described by Dietschi et al. in 1998 as “deep margin relocation,” the method gained wider acceptance as bonding strategies and material properties improved.[13] The term “deep margin elevation,” introduced in 2012 by Magne and Spreafico, more accurately reflects the coronal repositioning of the restorative interface.[14]

Indications for Deep Margin Elevation

Deep Margin Elevation is indicated when a proximal cervical margin extends below the gingiva but remains clear of the epithelial attachment.[25] Careful case selection is critical. To preserve periodontal health, the margin should remain about 2 mm coronal to the alveolar crest, respecting the supracrestal tissue attachment.[5]

DME is particularly useful in indirect restorations—such as inlays, onlays, and overlays—where deep margins complicate isolation, bonding, and impression procedures. In this sense, DME supports both restorative precision and periodontal stability.[2]

Adhesive success depends on strict moisture control, and even minor contamination can weaken the bond. Therefore, DME should be performed only when stable rubber dam placement is achievable; without it, the risk of failure increases significantly.[14, 26]

DME Technique

According to the protocol suggested by Magne et al. DME can be performed in all cases of deep proximal lesions when the following criteria are satisfied; [14]

i. The working field should be completely isolated.
ii. The matrix should isolate margins accurately and ensure a perfect seal around them.
iii. The connective compartment of BW must not be violated by the matrix

Preoperative measurement of probing depth, bone sounding and periapical radiographs are required. [27]

1. Procedure.

Armamentarium

• Matrix band (Tofflemire / sectional matrix) • Wedges / Teflon tape • Dentin bonding agent
• Flowable or condensable composite • Diamond burs • Glycerin gel • Light curing unit

Step-by-step procedure:

1. Caries removal and matrix placement

- After placing a rubber dam, removal of the carious defect completely
- Placement of a circumferential stainless-steel matrix band around the tooth to seal cervical margin. [28]
- Curved matrices are preferred because they provide better gingival emergence profile
- Adequate buccal and lingual tooth structure is necessary for matrix stability. [29]
- Matrix should be:

oHigher than desired elevation level
oMay be trimmed 2–3 mm with scissors (allows the thin band to slide slightly subgingivally and achieve a better seal.) [14]

2. Matrix-in-matrix technique

Used in severely deep localized defects:

- Insertion of a sectional matrix vertically into subgingival area
- Passing it through a loosened Tofflemire or Apis matrix
- After reaching deepest point, securing with Tofflemire or Apis matrix
- Placement of anatomically shaped wedge
- If wedge distorts matrix profile: Use of Teflon, instead of wedge

3. Margin preparation

Before proceeding with bonding procedures, Magne et al. recommend the gentle re-preparation of the cavity margins using an ultrasonic instrument or a fine-grit diamond bur. This step aims to remove any debris or contamination that may have occurred during matrix placement, thereby optimizing the substrate for adhesive bonding. [12]

4. Immediate dentin sealing (IDS)

A multi-step etch-and-rinse adhesive system combined with Immediate Dentin Sealing (IDS) is often recommended. [12]

Purpose: Improve bond strength, Reduce microleakage, long-term stability.

5. **Margin elevation with composite**

- Flowable composite resin alone or in combination of condensable composite ("snow-plow" technique) is then applied incrementally to elevate the margin by approximately 1.5 to 3 mm. [72]
- Preheated composite resin (at approximately 55 ◦C) is preferred, as the increased temperature reduces the viscosity of the material, allowing for an improved adaptation to cavity walls and minimizing the risk of void formation. [35]

6. Final polymerization

- Polymerization using glycerin gel (air-blocking) to eliminate oxygen inhibition layer

7. Finishing and polishing

- Rinsing of preparation with air-water spray

- Removal of excess composite using: Sickle scaler or No. 12 blade
- Polishing restoration properly

8. Radiographic evaluation

Postoperative bitewing radiograph should be taken to detect gaps, detect overhangs and confirm proper margin.

Modifications

While conventional protocols stress rubber dam isolation and stable matrix use, an alternative "R2-technique" has been described by Frese et al. that omits both steps. [27] This approach is based on the idea that contamination can be controlled within a limited cervical area, without full-field isolation.

Clinically, the procedure involves acid etching and adhesive application, followed by a thin layer of flowable composite. A nanohybrid composite is placed directly over it without a matrix. Using the "snowplow" technique, both layers are light-cured together, allowing the uncured flowable resin to be displaced and improve adaptation before polymerization. [27, 30]

A summary of the 57 included studies is provided in Tables 1–4, organized by design and outlining materials, techniques, aging protocols, outcome measures, and key findings. The evidence spans laboratory studies, finite element analyses, clinical trials, and reviews, reflecting growing interest in DME but also considerable methodological variability.

Identification of Studies via Databases and Registers

Records identified from:
PubMed/MEDLINE (n = 309)
Cochrane Library (n = 33)
Scopus (n = 1499)

↓

Records excluded as duplicates or outside scope
(n = 1414)

↓

Records screened (n = 425)

↓

Records excluded due to relevance
(n = 351)

↓

Reports sought for retrieval (n = 74)

↓

Reports not directly examining DME or proximal box elevation
(n = 13)

↓

Reports assessed for eligibility (n = 59)

↓

Reports excluded:
Not written in English (n = 2)

↓

Studies included in review (n = 57)

Figure 1. PRISMA Flow Diagram

Table 1. Summary of in vitro studies included(23)

Author(s), Year	Study Type	Materials / Methods	Aging Simulation / Evaluation	Groups Compared	Key Findings
1. Palma et al., 2025	In vitro	Two-step self-etch adhesive; direct vs semi-direct composite	1 month water storage at 37°C	Direct vs semi-direct	Semi-direct showed equal or better bond strength
2. Daghrery et al., 2025	In vitro	Lithium disilicate CAD/CAM crowns + composite DME	Thermal aging; SEM	DME vs no DME	Marginal gaps increased after aging
3. Balci et al., 2024	In vitro	Bulk-fill, conventional, fiber-reinforced composites	Fracture test; 10,000 thermocycles	Different composites	Fiber-reinforced showed highest fracture resistance
4. Ismail et al., 2024	In vitro	Universal adhesives; different curing modes	Thermocycling + 6 months water storage; µTBS	Light-cure vs self-cure	Light-curing superior; aging reduced performance
5. Baldi et al., 2024	In vitro (micro-	Highly filled vs conventional	Micro-CT; 5000 thermocycles	Flowable types	Highly filled flowables showed better adaptation,

	CT)	flowables			fewer voids
6. François et al., 2024	In vitro	Highly filled flowables	Flexural strength; wear resistance; SEM	5 materials tested	Material selection critical for DME base layer
7. Bresser et al., 2024	In vitro	Direct composite, lithium disilicate onlay, endocrown (with DME)	Thermocycling; cyclic loading	3 restoration types	Endocrowns with DME showed superior biomechanics
8. Reddy et al., 2024	In vitro	Flowable vs incremental DME technique	SEM analysis	Bulk-fill vs incremental	Incremental technique showed less microleakage
9. Baldi et al., 2023	In vitro	Low, medium, high viscosity flowables	Micro-CT	Viscosity levels	Medium viscosity showed best adaptation
10. Fichera et al., 2023	In vitro	Composite for peripheral build-ups	Not specified	Novel vs traditional method	Novel approach improved seal and strength
11. Vichitgomen et al., 2021	In vitro	Composite vs RMGIC	Dye penetration; 10,000 thermocycles	Composite vs RMGIC vs control	Composite showed superior sealing
12. Zhang et al., 2021	In vitro	Lithium disilicate endocrown with DME	Microleakage; fracture resistance; thermocycling	DME vs no DME	Improved seal; similar fracture resistance
13. Juloski et al., 2020	In vitro	Resin composite DME + CAD/CAM inlays	SEM vs dye penetration	Evaluation methods	No correlation between methods
14. Da Silva Gonçalves et al., 2017	In vitro	Adper Single Bond 2 adhesive	Immediate bond strength test	With vs without DME	DME significantly improved bond strength
15. Jawaed et al., 2016	In vitro	Not specified	Dye penetration	DME vs no DME	Adhesive system critical for cervical sealing
16. Spreafico et al., 2016	In vitro	Composite relocation under CAD/CAM crowns	Microscopic marginal assessment	Relocation vs control	Improved marginal quality
17. Frankenberger et al., 2013	In vitro	Composite DME + ceramic inlay	5000 thermocycles; SEM	With vs without DME	Improved dentin marginal quality
18. de Mattos Pimenta Vidal et al., 2013	In vitro	Composite, RMGIC, open sandwich	Thermocycling; µTBS; nanoleakage	Direct vs sandwich vs indirect	Open sandwich less nanoleakage; indirect stronger
19. Lefever et al., 2012	In vitro	Various DME materials; self-etch adhesive	SEM marginal adaptation	Flowable vs packable	Material-dependent performance
20. Roggendorf et al., 2012	In vitro	Ceramic inlay over composite DME	5000 thermocycles; SEM	With vs without DME	DME enhanced marginal adaptation
21. De Goes et al., 2008	In vitro	Intermediate flowable resin layer	µTBS test	With vs without flowable	Flowable improved bond strength (system-dependent)
22. Stockton et al., 2007	In vitro	Composite resin	Dye penetration	Not specified	Bonding quality crucial for dentin sealing
23. Loguercio et al., 2002	In vitro	Class II restorations; bonding techniques	Dye penetration	Total-etch vs open sandwich	Sandwich technique reduced microleakage

Summary of in vivo studies included(11)

Author(s), Year	Type of Study	Materials / Methods	Follow-up / Evaluation	Groups Compared	Key Findings
Roshdy, B.N., Eltoukhy, R.I., Ali, A.I. et al.	randomized clinical trial	injectable DME materials used: highly viscous glass ionomer (HVGI), high-filled injectable composite resin (ICR), resin-modified glass ionomer (RMGI), and bioactive ionic resin (BAIR) + nanoceramic-resin CAD/CAM onlay	Gingival health and restorative performance were assessed over a three-year evaluation period	four groups of injectable DME materials used: highly viscous glass ionomer (HVGI), high-filled injectable composite resin (ICR), resin-modified glass ionomer (RMGI), and bioactive ionic resin (BAIR).	All restorations were evaluated with a 100% recall rate and a 100% survival rate.
1. Hausdörfer et	Prospecti	Composite DME +	12-month	Indirect partial coverage	No significant periodontal

al., 2024	ve clinical trial	CAD/CAM lithium disilicate restorations	periodontal assessment	with DME vs without DME	differences between groups
2. Adson et al., 2024	Clinical trial	Composite-based margin elevation under indirect restorations	6-month clinical follow-up	DME vs non-DME	Clinically acceptable short-term outcomes; tooth structure preserved
3. Gözetici-Çil et al., 2024	Prospecti ve clinical trial	Indirect resin composite + proximal box elevation	Up to 3 years; FDI criteria	Posterior indirect restorations with DME	Predictable outcomes up to 3 years
4. Aziz et al., 2024	Long-term clinical & radiograp hic study	DME under CAD/CAM ceramic crowns	10-year evaluation	Crowns with DME vs without DME	Viable long-term option for subgingival margins
5. Cieplik et al., 2022	3-year randomiz ed clinical trial	Self-adhesive bulk fill vs conventional bulk fill composite	USPHS criteria; 3-year recall	Self-adhesive bulk fill vs conventional system	Both acceptable; conventional showed better marginal esthetics
6. Muscholl et al., 2022	Retrospe ctive clinical study	Composite-based DME	Up to 5-year clinical follow-up	Subgingival Class II composite restorations with DME	Reliable long-term performance
7. Bertoldi et al., 2020	Clinical & histologi cal study	Composite-based DME	Clinical evaluation	Subgingival vs supragingival margins	Mild inflammation but no attachment loss when properly finished
8. Bresser et al., 2019	Long-term clinical evaluatio n	Indirect restorations with composite DME	12-year follow-up; USPHS criteria	Single group (with DME)	High longevity over 12 years
9. Ferrari et al., 2018	Controlle d clinical study	Cervical margin relocation evaluation	12-month periodontal follow-up	CMR vs control (no CMR)	No detrimental periodontal effects over 12 months
10. Oppermann et al., 2016	Clinical trial	Composite restorations	12-month periodontal assessment	Subgingival restoration vs crown lengthening	Slightly more inflammation in subgingival group; no attachment loss
11. Andersson et al., 2004	Clinical study	Open-sandwich technique using RMGIC	6-year follow-up	Open-sandwich restorations	Supports long-term durability of RMGIC open-sandwich technique

Summary of questionnaire-based study and reviews included(20)

Author(s), Year	**Type of Review**	**Materials/ Methods**	**Means of Evaluation**	**Groups Compared**	**Key Findings**
ElHaddad SA et al. 2026	systematic review and meta-analysis	Adhesives/composites for DME	N/A	DME vs. non-DME	CMR is effective for managing subgingival margins and compatible with periodontal health when appropriate materials are used.
Jethwani et al. 2026	questionnaire-based study	20 closed-ended questions	N/A	dentists at dental educational institutions, private dental practices	moderate DME awareness among the study participants.
1. Sadeghnezhad et al., 2024	Systematic Review	Adhesives/composites for DME	N/A	DME vs. non-DME	DME reduces microleakage compared to non-DME
2. Ismail et al., 2024	Literature Review	Clinical protocols and case selection	Literature review	N/A	Highlights the need for clear guidelines and careful case selection
3. Alizadeh et al., 2024	Review & Clinical Commentary	Indications and periodontal considerations	N/A	N/A	Emphasizes respecting periodontal tissues during DME
4. Alam et al., 2024	Case Report & Review	Surgical and restorative materials	N/A	N/A	Proper management avoids biologic width violation

5. Chun et al., 2023	Systematic review	DME procedures and periodontal parameters	N/A	Various DME materials vs. controls	DME generally safe for periodontal health; sometimes improves it
6. Eggman et al., 2023	Systematic Review	Adhesive systems for subgingival margins	N/A	N/A	DME is a conservative alternative to surgery
7. Felemban et al., 2023	Systematic review	Various DME materials	Clinical data	DME vs. no DME (periodontal health)	No adverse effects on periodontium when properly performed
8. Samartzi et al., 2022	Literature Review	Review of clinical and lab studies	N/A	N/A	DME improves restorative success, alternative to crown lengthening
9. Ismail et al., 2022	Systematic Review	Bonding agents in DME	Thermocycling, μTBS, SEM	Various DME protocols	Satisfactory adaptation and bonding with proper adhesive technique
10. Aldakheel et al., 2022	Narrative Review	Adhesives/composites for DME	N/A	Conceptual analysis	DME is effective with proper case selection
11. Plotino et al., 2022	Literature Review	Surgical extrusion, replantation, transplantation	Literature-based review	Surgical extrusion vs. replantation vs. transplantation	Surgical extrusion can be viable when DME or crown lengthening is not
12. Juloski et al., 2018	Narrative Review	Composite DME with adhesive indirect restorations	Thermocycling and fatigue (in included studies)	Various DME protocols and materials	DME generally effective if executed properly
13. Sarfati et al., 2018	Narrative Review	DME and supracrestal tissue attachment	Literature analysis	DME vs. crown lengthening	DME avoids surgery if tissue management is respected
14. Dablanca-Blanco et al., 2017	Clinical Guideline & Review	Class II direct/indirect restorations with/without crown lengthening	Review with clinical criteria	Restorative vs. surgical margin control	DME feasible if isolation and tissue health are adequate
15. Mugri et al., 2021	Systematic Review	DME or crown lengthening	N/A	Crown lengthening vs. DME	DME is conservative and effective vs. crown lengthening
16. Frese et al., 2014	Clinical Technique Description & Critical Literature Review	Presentation of the R2-technique for proximal box elevation	N/A	N/A	Supports resin composite PBE to preserve biological width and periodontal health
17. Bazos & Magne, 2014	Review	Biomimetic restorative materials	N/A	Only conceptual	Biomimetic approaches improve esthetics and longevity
18. Magne&Spreafico, 2012	Narrative Review	Composite, 4th gen bonding agent	N/A	N/A	Introduced the DME concept as a restorative alternative to crown lengthening
19. Veneziani et al., 2010	Narrative Review with Protocol	Subgingival margin classification (Class I–IV)	Clinical examples	Subgingival margin classes	Classification system guides decision-making
20. Padbury et al., 2003	Narrative Review	N/A	N/A	N/A	Margins violating STA (biologic width) cause inflammation and attachment loss

Summary of studies (protocol papers, finite element analyses) included (3)

Author(s), Year	**Type of Review**	**Materials/ Methods**	**Means of Evaluation**	**Groups Compared**	**Key Findings**
1. Wu et al., 2024	Finite element analysis	Biomechanical comparison of restorative designs after DME	3D modeling and stress distribution analysis	Endocrown, inlay crown, and post-core crown after DME	Endocrowns after DME may be biomechanically more favorable than traditional post-core designs
2. Mahmoudi Yamchi et al., 2024	Finite element analysis	DME with composite vs. resin-modified glass ionomer under e.max endocrowns	3D finite element stress distribution analysis	DME with composite vs. RMGIC	Biomechanically, supports the use of composite over RMGIC as DME base

					under endocrowns biomechanically
3. Dietschi & Spreafico, 1998	Clinical technique paper	Adhesive cementation with viscous, densely filled resin cements; layering approach	N/A	N/A	One of the earliest descriptions of a stratified adhesive cementation approach; highlights clinical limitations of earlier adhesive systems and provisionalization methods

III. Results

Microleakage and Marginal Integrity

Maintaining a continuous, well-sealed margin is one of the main challenges in Deep Margin Elevation. Bonding at deep cervical areas is technique-sensitive, and achieving stable matrix adaptation can be difficult. Even small discrepancies may create gaps that allow fluid and bacterial penetration. [48]

Material choice is critical. Bulk-fill flowable and some bioactive composites show favorable marginal adaptation under controlled conditions, whereas conventional glass ionomer cements demonstrate weaker long-term stability, especially under load and moisture changes.[38] Flowable composites adapt well to irregular contours due to their low viscosity, but thicker layers can increase polymerization shrinkage stress and promote microgap formation. [34] Limiting the volume of uncured flowable material—such as with the snowplow technique—may improve adaptation while reducing shrinkage effects. [42]

Bond Strength and Layering Considerations

Reliable adhesion at the relocated cervical margin is essential for DME success. Because bonding often occurs on deep dentin or cementum, the integrity of the adhesive interface largely determines long-term stability. Studies indicate that both flowable and condensable composites can provide comparable fracture resistance when used for margin elevation, with no significant impact observed from variations in the DME layer height. [32]

Adhesive choice is equally important. Self-etch and universal systems are often preferred for radicular dentin or cementum due to reduced technique sensitivity and more predictable infiltration.[33] Still, bonding to root surfaces remains challenging because of their variable structure and organic composition. [68]

Some laboratory data suggest that warming multi-step etch-and-rinse adhesives may improve microtensile bond strength to dentin. While clinical confirmation is still needed, this approach could enhance interfacial durability in DME procedures. [69]

Periodontal Response

The periodontal impact of Deep Margin Elevation remains debated, with outcomes largely determined by the margin's distance from the alveolar crest. When the relocated margin lies within about 2 mm of the bone crest, the risk of violating the supracrestal tissue attachment increases and surgical crown lengthening is generally the safer option. [5]

Careful planning is essential. Radiographs and transgingival probing help assess bone levels and confirm whether adequate supracrestal attachment—slightly over 2 mm—remains. If this space is preserved and plaque control is good, DME can be performed without jeopardizing periodontal stability.

Restorative contour is equally critical. Over contoured margins or invasion of the attachment apparatus may promote plaque retention, inflammation, food impaction, and eventual restoration failure. Thorough finishing and polishing are therefore vital. Smooth, well-shaped composite surfaces limit biofilm accumulation and support healthy epithelial adaptation. Ultimately, periodontal success depends on respecting biological dimensions and executing the restoration with precision. [25]

Failure Rate and Clinical Longevity

Clinical evidence suggests that Deep Margin Elevation does not compromise restorative survival. Five-year studies report survival rates near 96%, with no significant difference between teeth treated with or without DME when properly executed. [53, 56]

Failures most often involve recurrent caries, fractures, or pulpal issues—complications common to adhesive restorations in general, not specific to DME. [65, 70, 71]

Outcomes also depend on the final restoration placed over the elevated margin. While DME was originally introduced to support indirect partial-coverage restorations, many recent studies focus on direct composite restorations, and others include partial-coverage or full crowns. This variation in restorative approach adds methodological diversity and may influence reported survival rates. [36, 51]

IV. Discussion

Critically evaluating Deep Margin Elevation means focusing on the factors that shape its predictability: adhesive choice, material selection and handling, and how the relocated cervical margin withstands functional load. Weighing mechanical performance against biological impact helps define when DME is a sound, evidence-based treatment choice. Current survival data must also be interpreted in light of study design and follow-up length, both of which influence conclusions about long-term reliability. [28]

Adhesive Strategies and Material Selection for Deep Cervical Margins

Bonding at deep cervical margins is one of the most technique-sensitive steps in Deep Margin Elevation. When the margin extends beyond the CEJ, enamel is no longer available, and adhesion relies on dentin or cementum—substrates with higher organic content and greater moisture sensitivity. Over-etching in these areas can damage collagen and weaken the bond. [30]

To reduce risk, many clinicians use a selective-etch approach: phosphoric acid for enamel, self-etch or universal adhesives for dentin. This preserves dentinal structure, lowers technique sensitivity, and supports consistent hybrid layer formation in deep areas. [28]

Earlier open-sandwich techniques used glass ionomer materials. Although resin-modified versions improved handling and moisture tolerance, studies show they offer lower bond strength and less stable margins than modern composites. [37, 39] As adhesive systems evolved, composite-based margin relocation became the preferred approach for better mechanical performance.

Flowable composites—especially highly filled types—are popular because they adapt well to irregular cervical areas and tolerate loading. However, their lower filler content makes them more prone to polymerization shrinkage, so thickness is typically limited to about 1–1.5 mm. Techniques like the snowplow method aim to improve adaptation while reducing contraction stress. [72]

Pre-warmed bulk-fill composites are another option. Heating improves flow and adaptation, while higher filler content enhances strength. Early laboratory and clinical findings suggest they perform well at or slightly below the CEJ. [69]

Layered composite techniques show marginal adaptation comparable to direct dentin bonding, while self-adhesive bulk-fill materials have yielded promising lab results but lack strong clinical validation. [46, 53] Dual-cure resin cements, by contrast, have shown poorer marginal adaptation in vitro and should be used cautiously for cervical margin relocation. [45,46,48,60]

Functional loading further challenges deep cervical margins. Finite element studies show that vertical forces concentrate stress at the cervical area—especially without enamel support—while oblique forces, common in premolars, increase tensile stress and risk of marginal breakdown. [40, 67, 73] Materials with an elastic modulus similar to dentin may better absorb and distribute these forces. High-filled flowable composites and resin-modified glass ionomers have been proposed for this reason, though evidence largely comes from laboratory simulations rather than long-term clinical trials. [68]

Material selection in Deep Margin Elevation should therefore consider not only bond strength and handling, but also elastic behavior and stress distribution under function to support long-term stability.

Long-Term Clinical Outcomes and Modes of Failure

Long-term data on Deep Margin Elevation (DME) are limited, but medium-term results are encouraging. In a prospective study, Bresser et al. found that molars restored with lithium disilicate and DME were easier to repair after fracture than restorations placed subgingivally without margin relocation. [31, 36]

Under simulated fatigue, composite-based DME performed better than glass ionomer approaches, supporting the routine use of resin systems. [58] Five-year data show survival rates near 96%, with no clear increase in secondary caries—even when margins extend apical to the CEJ. [70] Laboratory studies also report improved fracture resistance, though these findings cannot fully replicate clinical conditions. [65, 71]
Bresser et al. reported a five-year survival rate of 95.9%, with only a 2.5% incidence of secondary caries. [56]

Periodontal health remains a key determinant of success. Margins placed within about 2 mm of the alveolar crest are associated with more bleeding and plaque accumulation, likely due to disruption of the supracrestal tissue attachment. [25] When margins are well contoured, polished, and maintained with good plaque control, stable epithelial attachment can be achieved. [61, 74] However, concerns remain about possible inflammatory effects from resin monomer release. [55]

Overall, DME shows reliable medium-term performance when case selection, isolation, and adhesive protocols are carefully managed. Long-term durability, however, still requires well-designed prospective studies.

Deep Margin Elevation in Relation to Other Margin Relocation Approaches

Deep Margin Elevation (DME) offers a conservative way to manage subgingival margins by relocating them coronally with adhesive techniques rather than altering bone or soft tissue. Unlike surgical crown lengthening(SCL), which requires osseous recontouring and apical gingival shift, DME preserves periodontal architecture and avoids changes in crown-to-root ratio or gingival symmetry — concerns that, are especially relevant in esthetic areas. [19]

Orthodontic extrusion(OE) provides a more physiologic alternative by moving tooth structure coronally while maintaining tissue support. However, it demands longer treatment time, strict retention, and carries risks such as relapse or root resorption, particularly with accelerated protocols. [59, 75]

Although each approach has clear advantages and limitations, direct comparative trials are scarce. Data on patient-reported outcomes, healing time, esthetics, and cost remain limited, underscoring the need for stronger evidence to guide case selection.

Case Selection, Classification, and Clinical Guidance

Structured frameworks improve decision-making for Deep Margin Elevation (DME). Veneziani's three-tier system classifies cases based on isolation feasibility and margin proximity to the alveolar crest, helping clinicians judge whether adhesive relocation is practical or if surgical or orthodontic alternatives are needed. [63]

Classification of adhesive res2022torations with sub-gingival margins based on technical operating and biological parameters.

Grade I	On placement of rubber dam in the gingival sulcus, the cervical margin can be adequately visible.	DME can be performed
Grade II	A rubber dam is not sufficient to isolate the field, yet biological width is respected.	surgical exposition of the margin
Grade III	Deep sub-gingival margins violating the biological width	Surgical Crown Lengthening

Ghezzi et al. further refined this by incorporating periodontal anatomy, stressing that margins should stay within the junctional epithelium and avoid connective tissue attachment. This approach aligns DME with biological principles, minimizing inflammation and attachment loss. [66]

Individualized Assessment and Clinical Indications

Clinical judgment is crucial beyond classification systems. Factors such as gingival phenotype, precise margin location, and plaque control must guide DME selection. The anterior region demands extra caution due to esthetic concerns and thin periodontal biotypes prone to recession. Evidence for anterior DME remains limited, highlighting the need for further prospective studies. [17]

DME is best suited for direct adhesive restorations or indirect partial-coverage cases, enhancing isolation and bonding without altering tooth structure. It is less appropriate for full-coverage crowns, where the finish line must rest on sound tooth tissue for long-term stability and predictable margins. [28]

Summary of clinical tips suggested by the included evidence

i. DME is contraindicated if the tooth cannot be isolated' [76]
ii. A patient must be motivated, with good recall attendance
iii. Distance from the interproximal margin and the bone crest must be at least 2.0 mm. [25]
iv. 'Place reel matrix holder buccally or opposite corner from margin you are going to elevate. Insert handle. Don't tighten and loosen band repeatedly as it can start to unwind. Start tightening after placed matrix band around tooth. By using cord or superfloss by matrix can create a tight seal. [77]
v. 'Put rubber dam on first as the previous restoration will guide the rubber dam on. [78]
vi. 'If part of the rubber dam gets caught between the cavity and matrix, pull with an instrument outside of the matrix band to pull the rubber away [78]
vii. 'Use heavy rubber dam to retract the gum. Get a contact between the rubber and root and put on top of the rubber dam a floss ligature. For further retraction can introduce into the rubber a retraction cord or teflon tape. [78]
viii. 'Teflon tape can be packed when no wedge could be used due to damaging the profile of the matrix and therefore keeping the anatomical shape of the DME. [56]
ix. 'Teflon tape can be packed on the external part of the matrix to adapt the margin'

x. 'If more than 0.5 mm can use restorative composite with a brush [98] or pack each layer with a microbrush before curing'
xi. Glycerin can be used to remove the oxygen inhibitive layer. [77]
xii. Composite can be pre-heated using a calset warmer. [14]
xiii. To reduce risk of bacterial retention, do not use strips and burs to polish
xiv. Goal for the technique is to have no finishing apart from no. 12 blade to remove flash. [30]
xv. A post-operative bitewing is taken to confirm the proper adaptation of restorative material to tooth structure, especially when restoring prior to indirect restoration. [52]

Future Research Directions

Significant gaps remain in Deep Margin Elevation research. Long-term randomized comparative trials under clinical conditions should evaluate different composites, including highly filled flowables and preheated bulk-fill systems, to guide material selection based on durability, marginal adaptation, and biocompatibility.

V. Conclusions

DME offers a minimally invasive means to relocate subgingival margins, improving access and adhesive control. Margins should remain ~2 mm coronal to the alveolar crest and within the epithelial attachment to avoid inflammation and preserve periodontal health. Evidence favors highly filled flowables or preheated composites, though current literature is limited by variability and short follow-up. Standardized long-term studies are needed to confirm biological compatibility and performance, especially in esthetically or anatomically complex cases.

Abbreviations

The following abbreviations are used in this manuscript:
DME Deep Margin Elevation
STA Supracrestal Tissue Attachment
IDS Immediate Dentin Sealing
PTFE Polytetrafluoroethylene
GIC Glass Ionomer Cement
μTBS Micro Tensile Bond Strength
BoP Bleeding on Probing
PI Plaque Index
PPD Probing Pocket Depth
GI Gingival Index
SCL Surgical Crown Lengthening
RMGIC Resin Modified Glass Ionomer
OE Orthodontic Extrusion

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