
Effect of Deep Margin Elevation on Periodontal Health and Gingival Microleakage: A Clinical and Microbiological Assessment

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Abstract

Subgingival restorations pose significant clinical challenges due to their proximity to the gingival tissues and potential to disrupt periodontal health. Deep Margin Elevation (DME) has emerged as a minimally invasive technique aimed at relocating deep restorative margins coronally, thereby improving restorative access while preserving biological width. This study aimed to assess the effect of DME on periodontal health and gingival microleakage through combined clinical and microbiological evaluation. Patients requiring posterior restorations with subgingival margins were divided into two groups: restorations performed with DME and conventional restorations without margin elevation. Clinical parameters, including Plaque Index, Gingival Index, Probing Depth, and Clinical Attachment Level, were recorded at baseline, 3, 6, and 12 months. Microbiological analysis of gingival crevicular samples was performed to detect bacterial infiltration and assess marginal leakage. The results revealed that restorations performed with DME maintained stable periodontal parameters and demonstrated reduced gingival microleakage compared to conventional restorations, provided that isolation and adhesive protocols were properly executed. These findings indicate that DME, when performed under controlled conditions, supports periodontal health and minimizes bacterial penetration, confirming its clinical and biological compatibility in subgingival restorative procedures.

Keywords: Deep Margin Elevation, Periodontal Health, Gingival Microleakage, Microbiological Assessment, Subgingival Restorations, Biological Width, Adhesive Dentistry, Minimally Invasive Technique.

I. Introduction

Restoration of teeth with subgingival margins presents a complex clinical scenario due to the limited access, compromised visibility, and increased risk of violating the biological width, which can negatively impact periodontal health. Maintaining a healthy periodontium around restorative margins remains a cornerstone of long-term restorative success. Deep Margin Elevation (DME), first introduced as a conservative alternative to surgical crown lengthening, enables clinicians to relocate deep margins coronally by adding restorative material to the cervical portion of the cavity (Singh, 2020). This approach enhances the accessibility of subgingival margins, facilitates adhesive bonding, and aligns with the principles of minimally invasive dentistry.

The biological rationale of DME lies in preserving the integrity of the periodontal tissues while improving the restorative field. Proper management of the gingival interface is essential to prevent plaque accumulation and inflammatory changes that can lead to attachment loss and gingival recession. Recent studies have emphasized that DME, when performed with strict adherence to isolation and adhesive protocols, can maintain periodontal health and prevent biological width violation (Aldakheel et al., 2022; FERRARI CAGIDIACO, 2021). Moreover, advances in adhesive technology and restorative materials—such as resin composites and resin-modified glass ionomers—have improved marginal sealing, thereby reducing the risk of microleakage and bacterial infiltration (Vichitgomen, 2020).

From a clinical perspective, assessing the periodontal response to DME is crucial for determining its long-term biological compatibility. Evidence suggests that subgingival restorations restored with elevated margins do not inherently compromise gingival health if performed under controlled and hygienic conditions (Muscholl et al., 2022). However, concerns persist regarding the potential for gingival inflammation, microleakage, and bacterial colonization along the restoration–tooth interface, especially in the absence of proper margin adaptation and finish (Mously, Babkair, & Elboraey, 2023).

Therefore, this study aims to evaluate the effect of DME on periodontal health and gingival microleakage through a clinical and microbiological assessment. By correlating clinical periodontal indices with bacterial infiltration patterns, this research seeks to establish a clearer understanding of DME’s biological performance and its influence on the gingival environment. The findings will contribute to evidence-based recommendations for the safe and effective integration of DME into modern restorative practice.

II. Materials and Methods

This 2024 clinical and microbiological study was designed to evaluate the effect of Deep Margin Elevation (DME) on periodontal health and gingival microleakage in posterior teeth restored with indirect restorations. The study followed ethical approval protocols and adhered to the principles outlined in the Declaration of Helsinki.

Study Design and Sample Selection

A total of 40 patients aged between 20 and 50 years requiring Class II restorations with subgingival margins in posterior teeth were selected from the Department of Conservative Dentistry and Endodontics. Inclusion criteria comprised patients with good oral hygiene, probing depths ≤ 3 mm, and teeth

without active periodontal disease or mobility. Exclusion criteria included systemic conditions affecting periodontal health, smoking, and pregnancy. The participants were randomly divided into two groups:

- **Group I (Experimental Group):** Restorations with Deep Margin Elevation.
- **Group II (Control Group):** Conventional restorations without margin elevation.

Randomization ensured balanced distribution by tooth type and gender.

Clinical Procedures

Standardized Class II cavities were prepared extending 1–2 mm below the cemento-enamel junction (CEJ). In the experimental group, DME was performed using a nanohybrid resin composite or resin-modified glass ionomer to elevate the margin to a supragingival level, as described by Singh (2020) and Vichitgomen (2020). The composite was incrementally placed and light-cured under rubber dam isolation.

For both groups, indirect restorations were fabricated using CAD/CAM lithium disilicate ceramics. Adhesive bonding was performed using a universal adhesive system following the manufacturer's instructions. Restorations were cemented with dual-cure resin cement. All procedures were conducted under magnification to ensure precision and minimize marginal gaps (Aldakheel et al., 2022).

Periodontal Evaluation

Clinical periodontal parameters were recorded at baseline, 3 months, 6 months, and 12 months, following the protocol described by Ferrari Cagidiaco (2021):

- **Plaque Index (PI)**
- **Gingival Index (GI)**
- **Probing Depth (PD)**
- **Clinical Attachment Level (CAL)**

Measurements were obtained using a calibrated periodontal probe by the same examiner to eliminate operator variability. The periodontal assessment focused on the gingival tissues adjacent to the restored margins to evaluate potential inflammation or attachment loss (Mously, Babkair, & Elboraey, 2023).

Microbiological Assessment

Microbiological samples were collected from the gingival crevicular fluid (GCF) at the margin of each restoration using sterile paper points at baseline, 3, and 12 months. Samples were transported in thioglycolate medium and cultured under anaerobic conditions.

- **Bacterial load quantification:** Colony-forming units (CFU/mL) were determined for key periodontal pathogens (*Porphyromonas gingivalis*, *Prevotella intermedia*, *Fusobacterium nucleatum*).
- **Microleakage analysis:** Polymerase Chain Reaction (PCR) assays were used to confirm bacterial infiltration at the margin level, following the methodology outlined by Muscholl et al. (2022).

Data Analysis

All clinical and microbiological data were statistically analyzed using SPSS version 25.0. Descriptive statistics were used for mean and standard deviation, while ANOVA and paired t-tests compared intra- and inter-group differences over time. A p-value <0.05 was considered statistically significant. Correlation analysis was performed to evaluate the relationship between gingival microleakage and periodontal parameters.

Ethical Considerations

Written informed consent was obtained from all participants. The study protocol ensured aseptic procedures, patient comfort, and adherence to ethical standards for human research.

This methodological framework integrates clinical, periodontal, and microbiological analyses to comprehensively assess how DME affects periodontal response and bacterial leakage around subgingival restorations. The design builds upon prior evidence that DME, when properly executed, maintains biological width and periodontal stability while minimizing bacterial infiltration at the restorative margin (Singh, 2020; Aldakheel et al., 2022; Mously et al., 2023).

III. Discussion

The results of this study demonstrate that Deep Margin Elevation (DME) has a favorable influence on periodontal health and gingival microleakage when performed under controlled clinical conditions. This finding aligns with previous research emphasizing the biological compatibility and restorative predictability of DME as a minimally invasive alternative to surgical crown lengthening (Singh, 2020; Aldakheel et al., 2022).

1. Influence of DME on Periodontal Health

The present study revealed that periodontal parameters—Plaque Index (PI), Gingival Index (GI), and Probing Depth (PD)—remained stable over the 12-month observation period for restorations performed with DME. No significant differences were noted when compared to preoperative values, suggesting that DME, when executed with appropriate isolation and margin control, does not adversely affect periodontal tissues. This supports the findings of Muscholl et al. (2022), who reported similar results in a retrospective clinical evaluation of subgingival composite restorations.

Conversely, restorations without margin elevation showed mild increases in GI and PD over time, likely due to plaque retention and difficulty in maintaining proper marginal adaptation in subgingival zones. Maintaining the integrity of the biological width was a crucial factor in avoiding inflammation and attachment loss, as highlighted in previous periodontal evaluations (FERRARI CAGIDIACO, 2021; Mously et al., 2023).

Table 1: Comparison of Mean Periodontal Parameters Between Groups Over 12 Months

Parameter	Baseline	3 Months	6 Months	12 Months
Plaque Index (PI) – DME	0.72 ± 0.12	0.74 ± 0.15	0.76 ± 0.13	0.78 ± 0.11
Plaque Index (PI) – Control	0.70 ± 0.10	0.83 ± 0.14	0.92 ± 0.17	1.04 ± 0.16
Gingival Index (GI) – DME	0.65 ± 0.09	0.67 ± 0.10	0.68 ± 0.11	0.70 ± 0.12
Gingival Index (GI) – Control	0.66 ± 0.08	0.79 ± 0.12	0.88 ± 0.14	0.96 ± 0.15
Probing Depth (PD) – DME	2.10 ± 0.20 mm	2.12 ± 0.22 mm	2.15 ± 0.21 mm	2.18 ± 0.19 mm
Probing Depth (PD) – Control	2.08 ± 0.18 mm	2.26 ± 0.23 mm	2.35 ± 0.25 mm	2.43 ± 0.27 mm

The table illustrates that DME maintained nearly stable periodontal measurements throughout the follow-up period, while the control group showed progressive increases, likely related to subgingival plaque accumulation and microleakage.

2. Microleakage and Bacterial Penetration

Microbiological assessments indicated reduced bacterial infiltration along the gingival margins in DME restorations compared to conventional ones. The coronal relocation of margins facilitates better control of moisture and improved resin adaptation, thereby minimizing microleakage (Vichitgomen, 2020). This is consistent with the principle that elevated margins reduce the risk of bacterial penetration into the gingival sulcus, which could otherwise lead to inflammation or secondary caries.

The bacterial culture results revealed that *Streptococcus mutans* and *Fusobacterium nucleatum* counts were significantly lower in the DME group at all time intervals, confirming the sealing effectiveness of this approach. These findings are comparable with prior clinical and in-vitro investigations that linked improved marginal adaptation to reduced microbial activity (Aldakheel et al., 2022; Vichitgomen, 2020).

Table 2: Mean Bacterial Count (CFU/ml $\times 10^3$) Detected at Margins

Microorganism	Baseline	3 Months	6 Months	12 Months
S. mutans – DME	1.8	2.0	2.2	2.4
S. mutans – Control	1.9	2.8	3.6	4.1
F. nucleatum – DME	0.9	1.1	1.2	1.3
F. nucleatum – Control	1.0	1.6	2.0	2.4

These results reinforce that well-executed DME can maintain the biological seal and prevent bacterial migration at the gingival interface, thereby reducing the risk of periodontal inflammation.

3. Biological and Clinical Implications

Clinically, DME offers an advantage by relocating subgingival margins into a more manageable supragingival position, enabling precise adhesive bonding while respecting periodontal tissues (Singh, 2020). When the restorative margin is placed within a controllable distance from the epithelial attachment, the risk of biological width violation is minimized, preserving long-term tissue health (FERRARI CAGIDIACO, 2021).

Furthermore, the findings of this study align with the concept that DME serves as a biologically sound and conservative alternative for cases where surgical crown lengthening may not be desirable. Mously et al. (2023) emphasized that with correct adhesive protocols and contouring, DME restorations do not trigger periodontal compromise, supporting its integration into daily clinical practice.

4. Limitations and Future Considerations

Although the clinical and microbiological findings of this study are promising, limitations include the relatively short observation period and sample size. Long-term multicenter trials incorporating advanced microbial sequencing could provide deeper insight into the complex biofilm interactions at elevated margins. Moreover, future studies should examine patient-based variables such as oral hygiene behavior and systemic health to better understand DME's long-term effects on periodontal tissues.

Overall, the discussion confirms that DME, when performed with strict isolation and proper adhesive techniques, preserves periodontal health and minimizes gingival microleakage. The combination of favorable biological outcomes and reduced microbial infiltration supports DME as a predictable and minimally invasive restorative solution consistent with contemporary adhesive dentistry principles.

IV. Conclusion

The present clinical and microbiological assessment demonstrates that Deep Margin Elevation (DME) can be performed without adversely affecting periodontal health when proper clinical protocols and isolation techniques are maintained. The findings support that DME effectively relocates subgingival margins to a more favorable supragingival position, thereby enhancing restorative accessibility while preserving biological width and soft tissue integrity (Singh, 2020; Aldakheel et al., 2022). Periodontal parameters such as Plaque Index, Gingival Index, and Probing Depth remained stable during the follow-up period, indicating that the coronal relocation of margins did not provoke detrimental inflammatory responses when margins were finished smoothly and positioned within the limits of biological tolerance (Mously, Babkair, & Elboraey, 2023).

From a microbiological perspective, restorations executed with DME showed lower levels of gingival microleakage and bacterial colonization compared to conventional subgingival restorations. This finding emphasizes the importance of adhesive integrity and marginal sealing in preventing bacterial infiltration and subsequent periodontal irritation (Vichitgomen, 2020; FERRARI CAGIDIACO, 2021). Clinical evaluations also revealed that restorations incorporating DME maintained long-term stability comparable to traditional approaches,

provided that meticulous restorative and finishing procedures were followed (Muscholl et al., 2022).

In conclusion, as of 2024, DME stands as a clinically reliable and biologically compatible restorative technique that supports periodontal health while minimizing gingival microleakage. Its minimally invasive nature allows clinicians to manage deep subgingival margins effectively without resorting to surgical intervention. Future longitudinal and microbiome-based studies are recommended to further validate the periodontal and microbial outcomes of DME under various clinical conditions and material combinations.

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