International Journal of Applied Dental Sciences 2024; 10(2): 333-337

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2024; 10(2): 333-337

www.oraljournal.com
Received: 01-04-2024
Accepted: 05-05-2024

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Evaluation of marginal sealing and fracture resistance in indirect restorations with deep margin elevation

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DOI: https://doi.org/10.22271/oral.2024.v10.i2e.1959

Abstract
Introduction: Deep interproximal lesions pose a significant clinical challenge, as they are often associated with extensive cavities and subgingival margins, rendering restorations more susceptible to marginal leakage, secondary caries, marginal discoloration between the tooth/restoration, and adhesive failure.
Objective: To conduct a review of literature published in high-impact journals regarding cervical or deep margin elevation (DME) and its effect on marginal sealing prior to metal-free indirect restorations; to evaluate the DME technique, resin materials used for elevation, microleakage, fracture resistance, and comparison between crown lengthening and DME in supporting tissues.
Methodology: A search was conducted in Pubmed, EBSCO, and Google Scholar databases. The terms "Proximal Box Elevation," "Deep Margin Elevation," "Cervical Margin Relocation," "Microleakage," "Marginal adaptation," and "Fracture Resistance" were employed.
Results: When performing the DME technique, it is necessary to consider periodontal factors to avoid invading the biological width and to provide a better prognosis for the restoration. Additionally, it is important to carefully select materials and rigorously follow the protocol to reduce the risk of microleakage. DME enhances fracture resistance by improving the cavity shape where the indirect restoration is cemented.
Conclusion: The DME protocol and resin materials used for the technique can significantly influence microleakage, fracture resistance, and the health of surrounding periodontal tissues.

Keywords: Cervical margin relocation, indirect restorations, marginal adaptation, proximal margin elevation, fracture resistance, microleakage

1. Introduction

Deep interproximal lesions pose a significant clinical challenge for dentists, as they are typically associated with extensive cavities and subgingival margins. As the cavity becomes larger, the risk of resin polymerization shrinkage increases, which can lead to marginal leakage, secondary caries, and other issues that affect restoration adhesion [1].

The technique of cervical margin elevation, also known as cervical margin relocation or proximal box elevation, was first introduced by Dietschi and Spreafico in 1998 and subsequently revisited by Magne in 2012, who detailed the protocol and expected benefits of this procedure prior to the placement of indirect restorations [2]. This technique is also known by other terms such as deep margin elevation and coronal margin relocation [1].

Given polymerization shrinkage, these cases are often treated with resin or ceramic indirect restorations, as they offer favorable aesthetics, more precise morphology, better physical and mechanical properties, and reduce polymerization shrinkage due to their extraoral fabrication, which allows for the relief of residual stresses [2]. However, these lesions are often observed below the cementoenamel junction with subgingival margins, making clinical management difficult and potentially compromising restoration adhesion [3, 4].

Deep margin elevation (DME) presents as a conservative alternative that aims to obtain a new supragingival margin formed by resin, facilitating impression-taking, isolation, and cementation of the final restoration without compromising adjacent tissues and dental organs as would be done in the case of crown lengthening [5].

There are some literature reviews on this topic, where microleakage of DME is mainly evaluated, although the results of these studies vary considerably. Therefore, it is important to conduct a more detailed evaluation of this technique and consider it as an optimal treatment option before placing an indirect restoration in cases with subgingival margins.

The objective of this article is to conduct a review of literature published in high-impact journals on cervical margin elevation (DME) and its effect on marginal sealing before metal-free indirect restorations, evaluating the protocol, resin materials used, microleakage, fracture resistance, and the health of surrounding periodontal tissues.

2. Methodology

A search was conducted in the PubMed, EBSCO, and Google Scholar databases. The terms "Proximal Box Elevation", "Deep Margin Elevation", "Cervical Margin Relocation", "Microleakage", "Marginal adaptation", and "Fracture Resistance" were used in the advanced search.

3. Results

3.1 Deep Margin Elevation Technique (DME)

The first step in treating a deep interproximal cavity involves assessing the extent of the carious lesion or fracture, its proximity to the pulp, and the position of the margin in relation to the bone crest. This is achieved through periapical and bitewing radiographs, as well as by measuring probing depth and examining the surrounding bone [1].

The inclusion of a composite base beneath indirect adhesive restorations offers various benefits, such as facilitating access to difficult areas, streamlining the impression-taking process, and improving marginal adaptation [6, 7]. The immediate dentin sealing (IDS) technique, performed simultaneously with the elevation of the cervical margin (ECM), provides another significant benefit, as it involves the application of flowable resin onto freshly prepared dentin. This leads to increased retention, reduced marginal leakage, enhanced bond strength, and decreased postoperative sensitivity, all of which are benefits of IDS combined with ECM [8]. Additionally, ECM results in a reduction in the thickness and extension of indirect restorations.

Elevation of the cervical margin is achieved by directly placing composite resin, sculpting the missing walls with the aid of a modified Tofflemire curved matrix, to raise the gingival margin to a level where a rubber dam can be applied during restoration cementation. This allows for excess composite resin removal before final light-curing [9].

It is crucial to perform ECM after immediate dentin sealing, with absolute isolation and only if the margin can be adequately isolated with a modified curved matrix. Furthermore, the rubber dam should not interfere with the margin during composite placement, as this could affect sealing [2].

Recently, Pascal Magne has proposed a modification to the conventional technique, called the matrix-in-a-matrix (M-i-M) technique, which facilitates isolation and subgingival matrix adaptation by adding a sectional matrix within the modified circumferential matrix. Additionally, this technique further adapts the matrix by placing Teflon between the two matrices. Once the matrices are adapted, the conventional protocol is followed [8].

3.1.1 Conclusion

Throughout time, various alternatives have been explored to simplify the execution of this technique, and on multiple occasions, the protocol to follow and the expected benefits of carrying out this procedure before placing indirect restorations have been detailed. The common element considered indispensable for achieving the desired results is ensuring adequate absolute isolation using a rubber dam. This allows for moisture control, facilitates impression-taking, creates an optimal environment for adhesive procedures, and avoids the need to sacrifice healthy connective tissue through crown lengthening surgery.

3.2 DMC V.S. Coronary lengthening

Crown lengthening is a surgical procedure aimed at exposing gingival margins by apically displacing periodontal support structures to facilitate access and ensure adequate isolation [8]. Its purpose is to achieve the optimal position of deep restorations to avoid compromising the biologic width [10]. Maintaining a minimum distance of 3 mm between restoration margins and the alveolar crest is considered essential to prevent adverse effects on surrounding periodontal tissues [11], which sometimes requires bone reduction.

Significant changes in bone level, keratinized gingiva, and probing depth are observed within three months after surgery. Loss of attachment may compromise the crown-root relationship and expose root concavities or furcations [2]. Cervical margin elevation is considered a more conservative and beneficial approach for cases with deep cervical margins [12].

A randomized clinical trial compared clinical outcomes after crown lengthening and cervical margin elevation in posterior teeth; at 180 days, greater loss of attachment was observed in the surgery group [13]. Studies suggest that subgingival restorations and cervical margin elevation are compatible with periodontal health when adequate isolation is achieved, the margin is properly polished, and the biologic width is not invaded, followed by rigorous supportive therapy and good oral hygiene [10, 14].

Bleeding upon probing is expected if margins are placed 2 mm from the alveolar crest, regardless of the plaque index [15]. The distance between resin restoration and the alveolar crest should be more than 2 mm to prevent apical bone migration [16].

Furthermore, a systematic review concluded that cervical margin elevation has a better survival rate than crown lengthening; cervical margin elevation is recommended when the lesion reaches the gingival sulcus up to the junctional epithelium, but when caries invades the connective tissue, crown lengthening is needed [5].

3.2.1 Conclusion

Cervical margin elevation has shown proper integration with periodontal tissues, as long as the biologic width is not infringed upon, and the patient maintains regular check-up visits with proper plaque management. Cervical margin elevation cannot replace crown lengthening in situations where the biologic width is compromised or when the distance from the crest to the cervical margin is less than 2 mm.

3.3 Materials used in DME resin increment

The correct selection of materials is crucial for anticipating treatment success [17]. One study evaluated the marginal sealing of composite resin and glass ionomer-modified resin in the EMC technique before placing ceramic restorations. No significant differences were found in microleakage between the non-EMC group and the composite resin group at the dentin-resinous material interface. However, the glass ionomer-modified resin EMC group showed significantly higher microleakage [18].

In another study, self-adhesive resin cements showed more spaces in dentin after thermomechanical loading, suggesting avoiding their use [19]. Comparing composite resin and self-adhesive cement for EMC, there were no significant differences in dentin space formation between EMC and non-EMC groups using incremental layering with composite resin, while self-adhesive resin showed poor marginal adaptation [20].

Another study evaluated seven resin materials in EMC, with variable results. The group with a two-step self-etch adhesive system and low-shrinkage composite showed better marginal adaptation [21]. No significant differences were found in fracture resistance between groups restored with and without DME, nor in fracture resistance with various materials as DME [22, 23].

In summary, the use of composite resin with incremental technique in EMC is recommended to reduce polymerization shrinkage and microspaces at the dentin/EMC interface, considering that the adhesive system affects EMC performance.

3.3.1 Conclusion

It is suggested to use composite resin with an incremental approach in the restoration technique of resin-modified composites to reduce shrinkage during polymerization and minimize the formation of microgaps at the interface between dentin and the restorative material. Furthermore, the type of adhesive system used also affects the performance of this type of composites.

3.4 Microfiltration and fracture resistance

Fluids, bacteria, and products leaking through the adhesive interface can lead to postoperative sensitivity, marginal pigmentation, and recurrent caries, alongside tooth or restoration fractures, which are the primary causes of restoration failure [23]. Hence, ensuring marginal sealing of restorations is crucial for their longevity [24]. Some authors suggest that the selection of the adhesive system used in adhesive cementation (AC) and cementation are significant factors in restoration's marginal adaptation, along with the EMC material [25]. Direct cementation of ceramic restorations onto dentin results in higher rates of poorly adapted margins compared to indirect restorations bonded to DME (92% vs. 84%) [20]. A 2017 study compared different resin materials for their marginal adaptation with indirect restoration and dentin, with favorable results for EMC, indicating its potential as an alternative technique for deep proximal margins [26].

From a clinical standpoint, some authors conclude that EMC doesn't adequately seal the cervical margin of dentin, regardless of the composite resin material used and other variable factors such as difficulties in isolating the operative field, saliva presence, and challenges in achieving adequate sealing over the cement-dentin substrate, among others [27]. Polymerization shrinkage and inadequate hybridization between collagen fibers and adhesive agent in dentin can also affect adaptation [28]. Multiple studies have shown that EMC doesn't affect fatigue behavior and fracture resistance, irrespective of the restoration material, EMC material, or restoration design [3]. Proximal extension of the restoration is limited during EMC, resulting in more favorable stress distribution, even under higher loads and eccentric forces [22]. Additionally, EMC significantly increases fracture resistance, leading to more favorable fractures around the tooth-material bond. Combined with immediate dentin sealing (IDS), EMC enhances retention, reduces marginal leakage, and improves bonding strength [28].

When restoration is cemented directly on enamel margins or the EMC surface, the ceramic fracture rate is significantly lower (10%) than when cemented on the root cementum margin (90%). Authors suggest that ceramics with large occluso-gingival interproximal height are associated with increased fracture probability, especially when exceeding 5 mm, suggesting EMC prior to indirect restoration cementation [29, 30]. Microleakage results vary, but generally show higher probabilities between dentin and EMC than between EMC and indirect restoration. Mastering the EMC technique influences treatment performance. EMC enhances fracture resistance and improves the prognosis of cavitated pieces by better distributing occlusal forces, particularly in teeth with deep cervical margins.

4. Conclusion

To achieve satisfactory results with this technique, it is crucial to follow the protocol accurately and maintain adequate humidity control. The elevation of the cervical margin (EMC) treatment has been observed to be effective in cases with deep margins, improving fracture resistance and adaptation with periodontal tissues. However, there is no clear consensus on its effectiveness regarding marginal adaptation. Several studies, particularly systematic reviews and *in vitro* trials, indicate that further clinical research is needed to determine the viability of EMC as a treatment for subgingival cavities.

4.1 Conflict of Interest

Not available.

4.2 Financial Support

Not available.

6. References

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How to Cite This Article
Cerón-Flores LE, Sepúlveda-Leos MF, Cruz-Fierro N, García-Palencia P. Evaluation of marginal sealing and fracture resistance in indirect restorations with deep margin elevation. International Journal of Applied Dental Sciences. 2024;10(2):333-337.