Deep Margin Elevation for Indirect Restorations: A Systematic Review

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Authors’ contributions

This work was carried out in collaboration among all authors. Author KA provided concept of study, performed the statistical analysis, wrote the protocol, and first draft of the manuscript. Author NAA and HSAI did literature search, reviewed and extracted relevant data and wrote the manuscript. Author RMA reviewed and edited final draft. Author NHA did statistical application. All authors read and approved the final manuscript.

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ABSTRACT

Background: The evolution of adhesive dentistry has increased the demand for improving the clinical outcomes of indirect restorations. There are several challenging factors in restoring teeth with deep interproximal lesions. Surgical crown lengthening has been the primary procedure to avoid violation of the biological width. In recent years, deep marginal elevation (DME) has been proposed as an alternative procedure for maintaining biological width in cases with subgingival defects. The aim of this review was to search for the best available evidence concerning the clinical outcomes of DME.

Methodology: A comprehensive online search was performed using three different databases (using PubMed, the Cochrane Library, and the American dental association library for evidence-based dentistry). Four independent authors reviewed studies, collected data, and assessed the risk of bias.

Results: The initial search revealed 1,763 studies. Duplicates were removed, and an extensive
1. INTRODUCTION

In dental practice, restoring cavitated proximal caries lesions is a common routine procedure in dental chairs. However, subgingival margins reaching below the cemento-enamel junction are known to be a common clinical concern, especially when restoring severely destructed Class II caries [1]. Ideally, selecting the correct choice of treatment plan is critical to ensure successful outcomes.

The use of direct adhesive restoration to restore large interproximal defects is not an ideal treatment option. Due to their size, such defects usually require indirect adhesive restorations [2]. However, this appears to be challenging since cavity preparation, impression taking, the adhesive-bonding procedure, and proper moisture control may be impeded [3]. These challenges are usually overcome by crown-lengthening therapy.

Crown lengthening is a surgical procedure done to expose the gingival margins by apical displacement of the supporting periodontal structures, thus facilitating access and adequate isolation [4]. With the aim of achieving the optimum position of deep restorations to avoid violating the biological width [5]. Gargiulo et al. [6] defined the biological width as the gingival attachment along the root surface, from the most coronal portion of the epithelium attachment to the most apical portion of the connective tissue attachment. Therefore, a recommended distance of 3 mm or more between the restorative margins and the alveolar crest is considered necessary to avoid detrimental effects on neighboring soft and hard periodontal tissues [7-10].

Violation of the biological width results in severe gingival inflammation and, consequently, deep pocket formation or gingival recession, in addition to bone level reduction [11]. A study suggests that in the presence of good oral hygiene, with the exception of the biological width, other parameters, including probing depth, bone level, keratinized gingiva, and trans-sulcular probing, change significantly after crown-lengthening surgery within a three-month period [12]. A more conservative approach favored by patients is deep marginal elevation (DME), which is considered an atraumatic procedure advocated in the presence of deep cervical margins [13-16].

The concept of “deep margin relocation” was introduced in 1998 by Dietschi and Spreafico as a new approach to deep caries [14-16]. It was later renamed “deep margin elevation” by Magne and Spreafico in 2012. It is a procedure done to raise the margins of the tooth to either an equi-gingival or supra-gingival position using restorative materials. This technique is referred to by different names, including the “open sandwich technique,” “proximal box elevation,” and the “margin elevation technique” [14-16].

A randomized clinical trial compared the clinical results of crown lengthening and DME in posterior teeth. At 180 days, clinical attachment loss was higher in the surgical group [17]. Many studies have reported that DME procedures do not negatively affect periodontal health status and suggest they are well tolerated by the periodontium when proper isolation is achieved [5,18].

A dry working field is crucial to the success of restoration, especially in deep cavities reaching the Cemento-enamel junction. The presence of saliva and blood causes contamination and deterioration to the restoration and affects the bonding to the tooth structure [19]. DME allows appropriate placement of a rubber dam to a perfectly placed margin, adequate light-curing depth to the margin of restoration, accessibility to proper oral hygiene, and an ultraconservative approach to evaluate bone and soft tissue [15, 20]. Studies have shown promising results using DME and high survival rates of up to 90% over a 12-year clinical evaluation [17]. Therefore, the study aimed to search for the best available evidence.
investigating if DME results in successful clinical outcomes for indirect restorations.

2. MATERIALS AND METHODS

2.1 Search Strategy
The study aimed to search for the best available evidence investigating if DME results in successful clinical outcomes for indirect restorations. The research (PICOTS) question was as follows:

P = Adult patients with permanent teeth that have deep subgingival defects and require indirect restoration
I = DME using composite restorations
C = Surgical crown lengthening
O = Well-adapted restorations and healthy periodontium around the restored tooth
T = Three months of follow-up
S = Dental clinic

A systematic review was conducted using the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. A comprehensive search conducted for relevant studies published between January 2000 and January 2020 using PubMed, the Cochrane library, and the American dental association library for evidence-based dentistry. These electronic databases were used to search for relevant clinical trials and observational studies related to DME. The main search terms were “deep marginal elevation,” “margin relocation,” “proximal box elevation,” “proximal margin elevation,” and “open sandwich technique.” These keywords were used to develop the appropriate search strategy for each database. The search process was conducted from May 2020 to August 2020. Studies that met the inclusion criteria were evaluated and assessed to obtain the bibliography.

2.2 Selection Criteria
The review included English-published clinical trials and observational studies concerning DME on permanent teeth with deep subgingival defects requiring indirect restoration and a three-month follow-up. Articles published before January 2000, studies with less than three-month follow-up, studies on primary teeth, and in vitro studies were excluded.

2.3 Screening Process
The included studies were evaluated using Ex-GRADE(21) and the revised risk of bias assessment instruments. The process was completed to evaluate the quality of these studies and the recommendation. Four main reviewers (AN, AH, and AR, and AQN) assessed and extracted the data in an Excel sheet. Risk of Bias and Ex-GRAD were first applied to a pilot study to ensure reviewers had similar conceptions regarding these studies and to evaluate the quality of the studies. To keep track of references, End Note was used.

3. RESULTS

3.1 Search Results
The initial search of the electronic databases and additional records yielded 3,316 potentially relevant articles (Fig. 1). After reviewing the study titles, keywords, and research questions, 16 studies were assessed for their eligibility by retrieving the full text. Six studies met the inclusion criteria and were included in the review: two clinical trials, three case studies, and one case report.

3.2 Characteristics of the Included Articles
The characteristics of the included studies are shown in Table 1. A total of six eligible studies conducted between 2017 and 2020 were selected for this systematic review. The number of patients included in the studies ranged from 1 to 35 adult patients [5,21-26]. In most of the studies, the procedure was performed on posterior teeth [5,22,23,25,26]. Only one study involved the procedure being performed on an anterior tooth [24].

The intervention was DME or cervical margin relocation (CMR) in all included studies [5,22-26]. The application protocol of most of the studies was the application of a composite layer to elevate the subgingival margin, followed by indirect restoration [5,22-24,26]. Although one study performed DME with composite restoration solely [24].

The comparator was periodontal tissue to deep caries treated with subgingival composite restorations in five studies [5,22,23,25,26], and crown lengthening for one study, whereas no comparator was mentioned in one study [24]. The follow-up period ranged from three months to five years: three months [23], one year [22,25,26], two years [5], and five years [24].
The clinical procedures included [1] proper tooth isolation, followed by the DME/CMR technique; [2], avoidance of biologic width violation; and [3], composite resin use. All studies used the DME/CMR technique and were successful with proper isolation [5, 22–26]. However, one study mentioned that crown lengthening should be performed if the margin is close to the bone crest [25]. (Table 1).

4. DISCUSSION

The systematic review included six appropriate studies: two clinical trials, three case studies, and one case report. The purpose of this systematic review was to search for the best available evidence to investigate whether DME demonstrates successful clinical outcomes for indirect restorations. Overall, the results of the qualitative analysis confirm successful outcomes of DME when properly performed. Moreover, the results indicate that DME is a safe technique with no or minimal side effects reported. Nevertheless, these results should be interpreted with caution, as DME is technique-sensitive [3,5,22-25].

Isolation is a critical key to the success of the DME technique. In the six included studies, proper isolation was achieved prior to the DME procedure [5,17,22–26]. This systematic review suggests that the DME technique can be performed if proper isolation is achieved.

One of the main outcomes evaluated in the present study was periodontal health around the restoration. The results showed the compatibility of DME with periodontal health [5,17,18,22,23]. In particular, DME showed a positive periodontal health status comparable to crown lengthening. Additionally, the results showed a remarkable decrease in bleeding on probing [23], although one study reported a higher incidence of bleeding on probing [26].

Another important finding of the present systematic review is the DME effect on pocket depth. Among the included six studies, one study reported a significant decrease in probing depth [23], while another reported no difference among the three CMR approaches for pocket depth [22]. Furthermore, studies have reported that in the case of deep margins invading 2mm from the bone crest, crown-lengthening surgery is advocated to achieve the highest possible long-term success [25,26].
Table 1. Summary of the studies included in the systematic review

| Study                                                                 | Population (sample) | Intervention                          | Comparator                          | Outcome (result)                                                                 | Time                                                                 |
|----------------------------------------------------------------------|---------------------|---------------------------------------|-------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Cervical Margin Relocation: Case Series and New Classification System | 15 patients         | Cervical margin relocation             | Deep caries involving supracrestal tissue attachment | No differences were found among the three CMR approaches for pocket depth.       | 1-year follow-up then patients were followed with different periods, ranging between 2 and 8 years |
| Clinical and Histological Reaction of Periodontal Tissues to Subgingival Resin Composite Restorations | 29 participants     | DME                                   | Rest of the tooth surface           | A significant decrease in full mouth plaque score, full mouth bleeding score, and probing depth. In addition, clinical attachment gain occurred after three months. The inflammation level of gingival tissue was similar in both groups. | 3 months                                                             |
| Combined Endo-restorative Treatment of a Traumatized Central Incisor: A Five-Year Follow-Up | 1 case report       | DME                                   | NA                                  | A nanofilled composite resin combined with the use of the etch and rinse technique and a three-step adhesive influences the longevity of direct composite restorations, creating a reliable minimally invasive approach in cases of endo-restorative treatment after trauma. | 5 years                                                              |
| Deep Margin Elevation versus Crown Lengthening: Biologic Width Revisited | 4 case studies      | DME                                   | Crown lengthening                   | A proper isolation and emergence profile provided by composite material coping with indirect restoration can facilitate ideal periodontal integration. Histologically, it has been proven that the recreation of normal attachment apparatus is impossible. However, a healthy relation between periodontal tissue and dentin was observed. This technique proved to be compatible with gingival health. | 1–2 years                                                            |
| Study                                      | Population (sample) | Intervention        | Comparator | Outcome (result)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Time   |
|--------------------------------------------|---------------------|---------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Management of Large Class II Lesions in Molars: How to Restore and When to Perform Surgical Crown Lengthening? | 7 clinical scenarios | DME                 | NA         | The restoration in molar Class II will depend on the amount of healthy tissue remaining. DME can be performed whenever a matrix that allows raising the margin predictably can be used. In cases with invasion of the connective tissue or bone crest or those with deeper margins, crown-lengthening surgery is indicated as an attempt to achieve the highest possible long-term success of the restoration.                                                                                                                                                                                                                                                                                                                                 | 1 year |
| Influence of Cervical Margin Relocation (CMR) on Periodontal Health: 12-Month Results of a Controlled Trial | 35 restorations in 35 patients | Cervical margin relocation | Shoulder preparation; crown directly cemented to the dental structure | A higher incidence of BOP with CMR in deep margins placed at or closer than 2 mm from the bone crest.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1 year |
In accordance with the hypothesis, adequate follow-up time is essential for evaluating the clinical performance of DME. In the present study, the follow-up period was highly variable: three months in one study [23], one year in three studies [22,25,26], two years in one study [5], and five years in one study [24]. Although the follow-up periods were inconsistent, the overall follow-up period was rather short.

5. CONCLUSION

The systematic review advocates that DME is a reasonable, predictable, and reliable clinical procedure. DME appears to be well tolerated by the periodontium, both clinically and histologically. However, owing to the marked methodological heterogeneity across the included studies, as well as the high risk of bias in some of the included studies, more well-designed clinical trials with an appropriate follow-up period and consistent methodologies are strongly recommended for the clinical effectiveness of DME prior to implementation in clinical practice.

LIMITATIONS

In the present study, there are many limitations that should be acknowledged. The main limitations are the small sample sizes of some of the included studies and the heterogeneity among the included studies. In addition, there were variations in the length of the follow-up period.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Ethical approval for this study was obtained from the research center at Riyadh Elm University with the following registration number: FIRP/2020/61/254/245.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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