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Is Deep margin elevation a reliable tool for cervical margin relocation? – A comparative review

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ABSTRACT

The permanence of deep subgingival restorations are questionable both functionally and biologically. Crown lengthening is one of the traditionally performing procedures to visualize and relocate the deep margins, but the limitations of the invasive surgical procedure are anatomical complications like exposure of root concavities or furcation, violation of biological width, post operative discomfort because of sutures or periodontal packs; and less patient compliance. Other than crown lengthening, researchers tried some other techniques like modified matrix adaptation technique, using retraction cord, making holes in matrix band and flowing resin modified glass ionomer cement (RMGIC) to the root or cervical caries, orthodontic extrusion. But most of these procedures are failed to give adequate clinical success. Deep margin elevation (DME) is one of the minimally invasive and successful procedure performing in deep subgingival caries. But the evidences and knowledge in this technique is limited among practitioners. This review is to evaluate the applicability of DME, the current clinical concepts, techniques and materials for DME; and a comparison with traditionally used various techniques for cervical margin relocation also concluding that currently available various clinical parameters with this technique.

1. Introduction

Restorative dentistry started its journey from the era of Babylonians (4500–4000 BCE) and now the voyage has been reached to the most enthralling period with advancements in restorative techniques, materials and concepts. Minimally invasive dentistry (MID) superseded the extension for prevention. The silver amalgam displanted by the Biomimetics. Even though; the impediment in restoring deep sub gingival caries not only exasperats the operator but also suchlike restoration leads to violation of biological width, plaque accumulation, gingival irritation, bone loss and finally scarification of tooth.[1] The permanence of deep subgingival restorations are questionable both functionally and biologically. In 1998; Dietschi and Spreafico gave a solution for this knot by addressing deep margin elevation (DME).[2] Crown lengthening (CL) is one of the traditionally performing procedures to visualize and relocate the deep margins, but the limitations of the invasive surgical procedure are anatomical complications like exposure of root concavities or furcation, violation of biological width, post operative discomfort because of sutures or periodontal packs; and less patient compliance.[3] Other than CL, researchers tried some other techniques like modified matrix adaptation technique,[4] using retraction cord, making holes in matrix band and flowing resin modified glass ionomer cement to the root or cervical caries[5] and orthodontic extrusion. But most of these procedures failed to give adequate clinical success.

DME is addressed for restoring sub gingival caries with indirect restorations; furthermore, it can be also used for semi direct or direct restorative procedures following the same technique including the immediate dentin sealing (IDS).[3,6] But some of the challenges associated with DME are; adaptation of matrix band to the tooth structure, ability to maintain the isolation throughout the procedure and deficiency of sufficient clinical trials with long term results.

The primary goal of our review is to evaluate the applicability of DME, the current clinical concepts, techniques and materials for DME; and a comparison with traditionally used various techniques for cervical margin relocation also concluding that currently available various clinical parameters with this technique.

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2. Concept, procedure and materials

2.1. Concept of DME

DME is a doable alternative for surgical crown lengthening (SCL).[7] Advancements in the field material science and adhesive technology definitely have increased the success rate of DME. Concept of IDS along with DME increased the bond strength, fracture resistance, marginal integrity of indirect restoration and tooth structure and reduced the hypersensitivity that can happen after cavity preparation.[8] Cervical margin relocation, proximal box elevation, coronal margin relocation, open sandwich technique are some synonyms of DME has been used in various literature.[9]

In deep cavities the gingival margin is located sub gingivally, where the margin seldom supported by enamel or dentin. In the absence of a proper gingival seat, it is futureless to give a direct or indirect restoration. Because, this leads to gingival overhanging, violation of biological width, plaque accumulation, clinical attachment loss and finally destruction of tooth in total. The pre requisite while restoring a subgingival cavity is well maintained isolation and properly adapted matrix. Clinical studies show that DME is capable to restore subgingival cavities.[3] Modified matrix gives better penetration into the sulcus along with rubber dam, isolation is guaranteed. Cementing adhesive indirect restorations over direct composite has several advantages like adaptability; bonding; decreased thickness of indirect restoration and along with that IDS offers added advantages.[10–12]

2.2. Procedure for DME

In order to raise the gingival margin so that it can be sealed with a rubber dam during restorative delivery and allow for the correct removal of surplus luting composite resin before curing, direct composite resin is placed using a modified curved Tofflemire matrix. DME should only be accomplished if the margin can be effectively isolated using a modified Tofflemire matrix, immediately following IDS, and under rubber dam. If not, this method is contraindicated. Before taking the final impression, a bitewing radiograph should be done to assess how well the composite resin has adapted to the gingival areas. To benefit from the better isolation during root canal therapy, DME should be done whenever possible before to endodontic therapy. Matrix in matrix is used when cavities are exceedingly deep. In this technique sectioned fragment of metal matrix sliding between the margin and existing matrix.

Three-, four-, and five-surface direct composite resin restorations are being employed more frequently due to socioeconomic factors. The performance and quality of big direct restorations may be enhanced by the use of IDS and DME in conjunction with a delayed placement approach. As always, when planning and carrying out a treatment, considerations for the patient, the operator, and the material must be made. Fig. I illustrates schematic diagram of DME procedure.

2.3. Matrix

2.3.1. Modified tofflemire matrix

A Universal or Tofflemire retainer with a curved matrix (Greater curve or similar “Banana matrix”) is good enough to achieve proper DME.[3] Although a standard matrix will typically produce an insufficient gingival emergence profile and contour for margins located in the vicinity of the cement enamel junction (CEJ), it may allow the isolation and elevation of edges placed above the CEJ. The matrix must be supported by enough buccal and lingual walls of the remaining tooth structure. Localized elevation is feasible, however matrix instability and collapse will typically prevent extensive elevation in the buccal and lingual directions. Reduce the matrix height to 2–3 mm, which is a little higher than the desired elevation. The matrix’s narrowness will make it easier for it to slide subgingivally and effectively seal the margin.

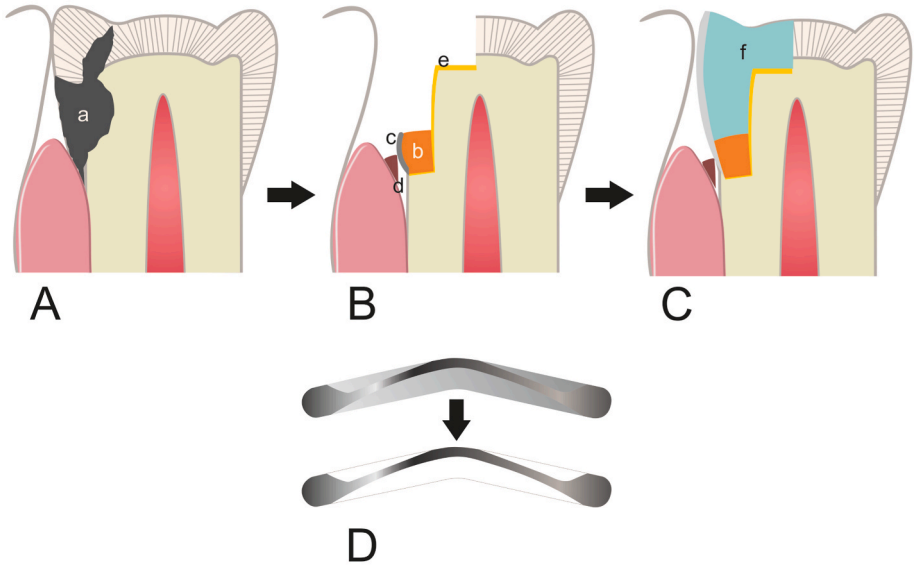

Fig. 1. Schematic illustration of DME technique
A-Preoperative image showing subgingival caries
B-Deep margin elevation and Gingival seat build-up
C-Restoration
D-Modified matrix band technique
a- Deep subgingival caries
b-Gingival seat build up with flowable composite
c-Modified matrix band
d-Wedge
e-Immediate dentine seal
f-Restoration with Bulk-fill composite.

Normally, wedging is not an option. After applying the matrix band, there shouldn't be any rubber dam material between the tooth and the matrix. This will provide a good seal.

2.3.2. Matrix in matrix (M.i.M)

When a lesion is exceedingly localized and deep, this method is the last resort. Between the margin and the current matrix in this approach is a metal matrix.,[3] unlike Barton's method; to retain the section matrix; it is not advised to use wedges, instead of that Teflon packs between section matrix and existing matrix will gives proper contouring and sufficient retention.

2.3.3. Reel matrix or cervical margin relocation matrix

Dr. Mathew Nejad introduces the reel matrix. This matrix method made the claim that it would provide deep marginal zones with good gingival flexibility and shape. In order to increase gingival adaptability in deep sulcular zones, it is pre-trimmed at a height. The matrix shape's narrow form offers the perfect contour for accommodating and lifting deep margin areas. The light weight of Reel matrix spool allows it to stay in place during the procedure without tipping or falling off as would a heavily weighted traditional retainer. The retainer comes with a particular chuck, which can be used to retain the Reel matrix to the tooth.

2.4. Materials

2.4.1. Glass ionomer cement (GIC)

DME typically performed with resin based composites and indirect restoration over that.[7] But the deep subgingival area is comparatively more compatible with a hydrophilic material such as GIC or RMGIC. In historical perspective, GIC could be placed in subgingival areas in conjunction with the open sandwich technique (OST) is good to implement cervical margin relocation.[13] The limitations associated with this hydrophilic material make less preferable option for DME. The higher solubility, compromised marginal adaptation, reduced long term fracture resistance, inability to bear thermo cyclic loading are some of the drawbacks while using GIC.[7] At the same time the fluoride recharging property, compatibility with the biological system, chemical bonding with dentin or cementum, similar coefficient of thermal expansion, no polymerization shrinkage unlike resin based composites (RBC) are the factors favoring GIC to be used as a material for DME. Some clinical studies shows that materials in the family of GIC have comparable properties as RBC.[14,15] Comparative in vitro study by TD Grubb et al. on proximal box elevation (PBE) showed GIC, RMGIC, RBC and bulk filled composite did not influenced the result in terms of the fracture resistance and marginal adaptation; and he concluded that the material of choice doesn't influence the DME outcome and any of the material could be used.[7] But the scarcity of clinical trials on this context makes it less conclusive.

2.4.2. Resin modified glass ionomer cement (RMGIC)

RMGIC is in the same family of GIC and shares the physical and biological properties equal or higher than GIC. RMGIC was introduced to overcome the drawbacks of GIC like moisture sensitivity and low fracture strength.[16,17] Unlike GIC, RMGIC sets via a combine acid-base reaction and polymerization because of the incorporation of the resin. Though, the in vitro bond strength of RMGICs is lesser than that of the RBC.[18] The lack of cohesive force within RMGIC will leads to intrinsic failure of the material before the debond and this might be the reason for low bond strength of RMGIC.[19,20] As mentioned previously, the in vitro studies showing the material of choice doesn't influence the success of PBE, but more research is required in this aspect.

2.4.3. Composites

Resin based composites are the typically recommended material for DME in the deep gingival areas.[2,3] Composite resin restoration can be applied successfully in deeper cavities, even when restorative margins are located below the CEJ.[21] Micro hybrid (MHC), Nano hybrid composites (NHC), Bulk fill (BFC), Flowable Composite (FC) are the different members of composite family used so far for DME. More than one kind of composite can be used for in the same preparation to get synergistic effect. Substantial volumetric shrinkage is inborn with composites. The shrinkage can lead to unwanted effects like marginal debonding, micro leakage, and secondary caries.[22–24] Currently all the researchers are concentrated to identify the most apt composite for DME with minimum polymerization shrinkage and maximum clinical success. Various in vitro and clinical trials ends up with the conclusion that the IDS with multi layering of different of composite gives appreciable success in terms of functional, mechanical and biological parameters.[25–27]

3. Comparison between deep margin elevation and traditional cervical margin relocation technique

Other than DME, other techniques to relocate cervical margins are; surgical crown lengthening, matrix in matrix technique, modified matrix technique and orthodontic extrusion. Table 1 illustrates the major difference between these techniques, the pros and cons, patient acceptance etc.

4. Discussion

Crown lengthening and orthodontic extrusion of teeth were the traditionally used procedures for management of tooth with deep subgingival caries. But the complications and impracticality associated with this invasive procedure always inspired the researchers to find a more practical, minimally invasive and bio-functionally acceptable management technique, and it finally ends up with DME or PBE. Furthermore, the procedure was introduced in 1998, still practitioners are not well aware of the procedure because of the lack of scientific literatures and clinical trials on this context. At the same time, there are number of in vitro studies evaluating the bond strength, marginal adaptation, fracture resistance and comparison of various materials for DME. The parameters governing predictable outcome for DME are the biological or periodontal integrity of the material, marginal adaptation of the material with the dentin/cementum of the tooth and the indirect restoration, microleakage that can happen between the interface of DME material-tooth and DME material-indirect restoration, bond strength between the material-tooth and material-indirect restoration, ability to bear the thermo cyclic loading without fracture.

4.1. Biological integrity

Irrespective of the type of restoration, the biological width, health of the periodontium should be respected.[30] But in the case of a deep subgingival caries, the restoration is placed deep in the sulcus, so the compatibility of the restorative material with the periodontium should be monitored for long term. Violation of the biological width, rough surface of the restoration will ultimately lead to periodontal failure of the restoration.[30] Plaque accumulation on the rough surfaces of deep subgingival restoration leads to gingivitis and subsequent periodontitis. The limited available clinical trials and case reports conclude that, the contemporary composite material, especially flowable and bulk fill composites offers appreciable periodontal integrity.[31] Even though, lack of proper maintenance will leads to failure.

4.2. Marginal adaptation and microleakage

In the case of composites, the marginal integrity is usually doubtful, because of the polymerization shrinkage. That is the reason behind the preference of indirect restoration over direct which offer a definite margin.[32,33] But in contemporary restorative dentistry, the advanced composites show minimum polymerization shrinkage. Scanning

Table 1
Comparison between deep margin elevation and traditional cervical margin relocation technique.

characteristic	DME	SCL	Modified matrix technique	Matrix in matrix technique (M.i.M)	Orthodontic extrusion
Proposed by	Dietschi and Spreafico (1998)	Cohen D W[28] (1962)	MG Brackett [4)] (2018)	Pascal Magne[3] (2012)	Heithersay and Ingber [29] (1976)
Concept	Placement of a modified Tofflemire matrix followed by immediate dentin sealing and coronal elevation of the deep margin to a supragingival position using direct bonded composite resin base	Relocating the affected area of a tooth to a supragingival position, leaving sound tooth structure exposed to improve tooth restorability, and providing space for the reestablishment of the biological width	Utilizing a modified Tofflemire matrix band that creates a preparation free of crevicular fluid and blood for restoration with light cure restorative material	Final option in case of an extremely deep and localized lesion	To preserve the biologic width, forcefully exposing sound tooth structure for optimal placement of restorative margins, and achieve esthetics
Restorative materials/ Instruments required	Resin based composite, Adhesives, equipment for isolation, Tofflemire matrix system	Bard parker surgical blade, Haemostatic agents, restorative material, Matrix system	Modified Tofflemire matrix system, Restorative material	Tofflemire matrix system, Segment of curved matrix band, Restorative material, equipment for isolation	Fixed orthodontic appliance with a hook, composite restorative material
Indications	Deep subgingival caries where isolation is possible	Deep subgingival caries where there is no violation of biologic width	Deep subgingival class II or V caries, Root caries where isolation is possible	Extremely deep and localized lesions	Periodontal healthy tooth, adequate root structure, without any pathology
Contra indications	Where proper isolation not possible with rubber dam, Tofflemire band not able to retract the gingival tissue, deep subgingival caries encroaching near to alveolar crest	Inadequate crown to root ratio, Esthetic compromise, High furcation, complicating anatomic features, Patients with bleeding disorders or any other kinds of pathology.	Where proper isolation not possible with rubber dam, Tofflemire band not able to retract the gingival tissue, deep subgingival caries encroaching near to alveolar crest	Where isolation is not possible	Unfavorable axial tooth position, Compromised periodontal health, Short roots that lead to inadequate crown-to-root ratio, and wide internal root form
Procedure	Refer 2.2	Crown lengthening surgery with external bevel gingevectomy, Internal bevel gingevectomy, Flap surgery with or without osseous resection	The center of the occlusal side of a universal Tofflemire No. 1 matrix band trimmed with fixedcurve crown scissors to a width of 3 mm using a curvature opposite that of the band on that side. The two ends of the matrix band were then trimmed by 1.5 cm each. The modified matrix was then molded using finger pressure to form the convex, arch-shaped facial contour of the tooth. The trimmed occlusal portion of the modified band became the gingival side of the custom matrix. Before placing the matrix, the retraction cord removed from sulcus. The modified matrix then placed around the prepared tooth and into the gingival sulcus where necessary. Two small Wizard wooden wedges placed on the mesial and distal sides to hold the matrix firmly in place and to seal the preparation against fluid contamination. Restoration can be done according to the manufacture instructions and extra material can be removed using finishing burs from the sulcus.	Sectioned fragment of metal matrix sliding between the margin and existing matrix.	A fixed orthodontic appliance can be used. The carious lesions were eliminated. Approximately 5 mm of gutta-percha removed from the root canal for ETT. A hook was fabricated with a piece of SS round wire, with several artificial notches on its body for improved retention following cementation. The hook cemented in the toot root canal with a temporary cement for RCT treated tooth or on the middle third of the remaining crown wirh resin composite. Also, a shaped archwire conforming to the arch and fixed on the buccal surface of the teeth, extending from one anchor tooth to the controlateral tooth and covered by flowable composite resin. The wire was adjusted so that it did not interfere with protrusive and excursive movements. An elastic thread passed between the hook and the archwire. The distance between the hooks and wire was determined, and the elastics were connected to the hooks on the provisional crown, curling around the supporting wire.
Marginal adaptation/ Microleakage	In vitro studies by SEM shows satisfactory external marginal integrity but micro CT studies are unsatisfactory.	Depends on the restorative material	–	In vitro studies by SEM shows satisfactory external marginal integrity but micro CT studies are unsatisfactory	–
Bond strength	In vitro studies show good bond strength. Enhanced because of IDS	Depends on the restorative material	–	In vitro studies show good bond strength. Enhanced because of IDS	–

(*continued on next page*)

Table 1 (*continued*)

characteristic	DME	SCL	Modified matrix technique	Matrix in matrix technique (M.i.M)	Orthodontic extrusion
Fracture resistance	In vitro studies reveals fracture resistance remains unchanged	Depends on the restorative material	–	In vitro studies reveals fracture resistance remains unchanged	–
Color stability	No studies yet	Depends on the restorative material	–	No studies yet	–
Clinical success	Good	Not predictable			
Advantages	Non invasive, Immediate result, IDS provide extra benefits, could be used for both direct and indirect restorations	Complete direct visualization of the gingival seat, No need of ant special matrix systems	Minimum of overhangs and proper interproximal contours; therefore, minimal finishing is required, Minimum armamentarium	Non invasive, Immediate result, IDS provide extra benefits, could be used for both direct and indirect restorations	Improved bone level, low cost, and less time
Disadvantages	Clinical outcomes not always satisfactory, Not possible where isolation is possible, Technique sensitive	Invasive procedure, Exposure of significant anatomic features, Inadequate predictability, Tooth arch relationship inadequacy, Compromise adjacent periodontium or esthetics, Insufficient restorative space, No maintainability	Not possible in all types of deep subgingival caries	Clinical outcomes not always satisfactory, Not possible where isolation is possible, Technique sensitive	poor esthetic outcomes during treatment and the need for more patient cooperation
Patient's preferences	More preferred because less invasive	Less preferred because of bloody field	Preferred	Preferred	Less preferred because of complex orthodontic appliances

electron microscopy (SEM) and micro computed tomography evaluation of the external marginal interface shows satisfactory result but the quality of internal interface is questionable especially when viewing through the SEM.[34] The cyclic thermo mechanical loading disturbs the marginal integrity, leads to microleakage, and then subsequent secondary caries.[10,35,36] Introduction of flowable composite managed the issues associated with marginal adaptation up to a limit. Relocating the deep sub gingival margin primarily with flowable composite followed by bulk fill composite ("snowplow technique") resulted reduction in the microleakage.[37]; but, one another retrospective study reports, the "snowplow" technique doesn't improve the clinical performance.[38] Delayed light curing,[39] soft start polymerization, incremental build up, application of IDS enhances the quality of margin.[40]

4.3. Bond strength

Adequate bond strength in the material-indirect restoration-tooth interface governs the longevity of the restoration. Several factors monitor the bond strength; increased thickness of indirect restoration in the proximal box region leads to increased attenuation in light irradiance results in decrease in the degree of curing of resin cement,[41] The interaction between resin cement for luting and resin composite, surface treated composite with aluminum oxide shows good bond strength,[42] IDS increases the bond strength further.[8,40,43] The factors reducing bond strength while doing DME are polymerization shrinkage, absence of enamel and bonding with dentin or cementum.[18,19,44] In vitro study conducted by Gonclaves et al. on bond strength by using G Cem and RelyX ARC cement concluded that; the largest benefit in terms of proximal box elevation technique was obtained with GCem cement, since it showed a significant increase in the bond strength. In the case of the RelyX ARC cement, the proximal box elevation did not affect the bond strength values obtained.[41]

4.4. Fracture resistance

A tooth with deep subgingival caries with or without MOD cavity, or an endodontically treated tooth (ETT) are fragile in nature because of the loss of natural tooth structure or dehydration in the case of ETT. So while performing the DME, the fracture resistance of the indirect restoration as well as the tooth structure should be enhanced. Commonly, ceramic inlays, onlays or composite indirect restorations are preferred in DME. In vitro study by Grubb et al. showed that the irrespective of the material of DME, it doesn't influence the fracture resistance of teeth.[7] Fracture strength of lithium disilicate onlay and inlay cemented through DME showed that without DME, onlay offers more fracture resistance than inlay but the final conclusion of the in vitro study was that DME did not statistically significantly affect the fracture strength, nor the fracture type or repairability of lithium disilicate restorations.[45] Available in vitro studies gives inconclusive result regarding the fracture resistance after DME and more clinical trials required to produce conclusion.

5. Conclusion

With the sufficient number of in vitro studies and limited number of clinical trials it could conclude that DME is a reliable option for the management of deep subgingival carries either by direct or indirect restoration. Complete isolation and manipulation of adhesives, other restorative materials, and postoperative maintenance will give the success of DME. The long term success of DME is inconclusive because of the scarcity of clinical trials. Furthermore, in future, we can expect more evidences on this context.

Declaration of competing interest

The authors declare no conflict of interest.

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