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Materials used for deep margin elevation (Review article)

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Abstract:

Background: Deep margin elevation (DME) is considered a conservative approach for restoring the deep proximal margin by applying restorative material over the existing cervical margin to reposition it coronally and facilitate the insertion of indirect restoration. Different materials have been used for the elevation of the deep margin. The present study aims to review the in-vitro studies and clarify the advantages and disadvantages of each restorative material used for the DME technique assessing fracture resistance, microleakage, marginal quality, and marginal adaptation. **Materials and methods**: An electronic search was executed using MEDLINE (PubMed) and Google Scholar databases using deep margin elevation, proximal box elevation, and cervical margin relocation to cover published studies from 2000 until 2024. A total of 938 articles were identified by the keywords and based on the inclusion and exclusion criteria, 16 articles were included. These in-vitro studies assess the DME technique in terms of fracture resistance, microleakage, marginal quality, and marginal adaptation all were analyzed and presented to suggest the best-recommended material and method based on evidence-based dentistry. **Results:** The studies showed that bonding indirect restorations to enamel margins had the best gap-free margins, followed by direct bonding to dentine. DME technique required careful layering of 1 mm increment to get fewer gaps. Following this technique, there was no significant difference in gap formation compared with those without margin elevation. DME didn't significantly influence the fracture strength in all of the materials utilized for DME except that elevated with smart dentine replacement material which has significantly higher strength than those without DME.

Conclusions: Based on this review, the conventional composite or bulk-fill composite preferred to be placed in multiple layers of 1 mm increment of DME to have fewer marginal gaps. DME is not preferred to be elevated with flowable composite, glass ionomer cement, resin-modified glass ionomer, and self-adhesive resin cement due to their low mechanical properties.

Keywords: Deep margin elevation, Proximal box elevation, Cervical margin relocation.

Introduction:

Subgingival margins, which usually form on the proximal aspect of a tooth and are challenging to detect at an early stage, are frequently observed on teeth that have significant loss of hard tissue due to deep cavities or severe defects in the tooth structure (Magne and Spreafico, 2012). It is recommended to restore these large restorations using indirect posterior bonded restorations with cuspal coverage (Veneziani, 2010; Magne and Knezevic, 2009). Clinically, the deep proximal margin challenge to be isolated from oral fluids like saliva, blood, and gingival sulcus fluid causing contamination of restorations during placement which reduces the bonding strength (Magne and Spreafico, 2012; Mangani et al., 2015). Also, the marginal accuracy of the impression for the indirect restoration might be affected. So, to restore a cavity with a deep margin, it is required to make the margin accessible above the gingiva (Magne and Spreafico, 2012). Surgical crown-lengthening treatment (SCL) and orthodontic extrusion are two clinical approaches that could be utilized to solve this problem. However, both these techniques have some limitations in certain clinical cases. In 1998 Dietschi and Spreafico suggested a technique of “cervical margin relocation (CMR)” in which the application of a composite resin layer could transform the subgingival margins supragingivally (Dietschi and Spreafico, 2019). “Deep margin elevation (DME)” (Magne and Spreafico, 2012) and “proximal box elevation (PBE)” (Roggendorf et al., 2012; Zaruba et al., 2013; Ilgenstein et al., 2015) are other terms used to describe this technique.

Several in vitro studies assessed the effect of the DME technique on the fracture strength, microleakage, marginal quality, and marginal adaptation of teeth restored with indirect adhesive restorations. However, there is insufficient information in the literature to provide definitive recommendations regarding the suitable material and thickness for DME; since most research concentrated on particular DME aspects. Thus, this study aimed to review the literature and clarify the advantages and disadvantages of each material used for DME concerning fracture resistance, microleakage, marginal quality, and marginal adaptation.

Materials and method:

Search strategy:

The National Laboratory of Medicine (PubMed), and Google Scholar databases were used to identify the research articles that have been published from 2000 until 2024. The search keywords applied to every database were deep margin elevation, proximal box elevation, and cervical margin relocation.

Inclusion and exclusion criteria:

The requirements for eligibility in this review included in vitro studies with permanent human teeth assessing fracture strength, marginal adaptation, marginal quality, and/or microleakage using different materials for DME. Articles should be written in English and report sensitivity and specificity values. Exclusion criteria include clinical trials and case reports, in addition to studies published in abstract form only with insufficient, nonspecific data for analysis (Figure 1).

Study selection:

To find the research that would fit the inclusion criteria, the first search was made. Second, two of this study's authors evaluated the abstracts of the selected papers. Third, in the searching phase, the authors thoroughly reviewed the texts that appeared to meet the inclusion criteria or that did contain information in the abstract that could have enabled us to make the right decision. If there was a disagreement on any study, all of the authors had a discussion to find an acceptable solution.

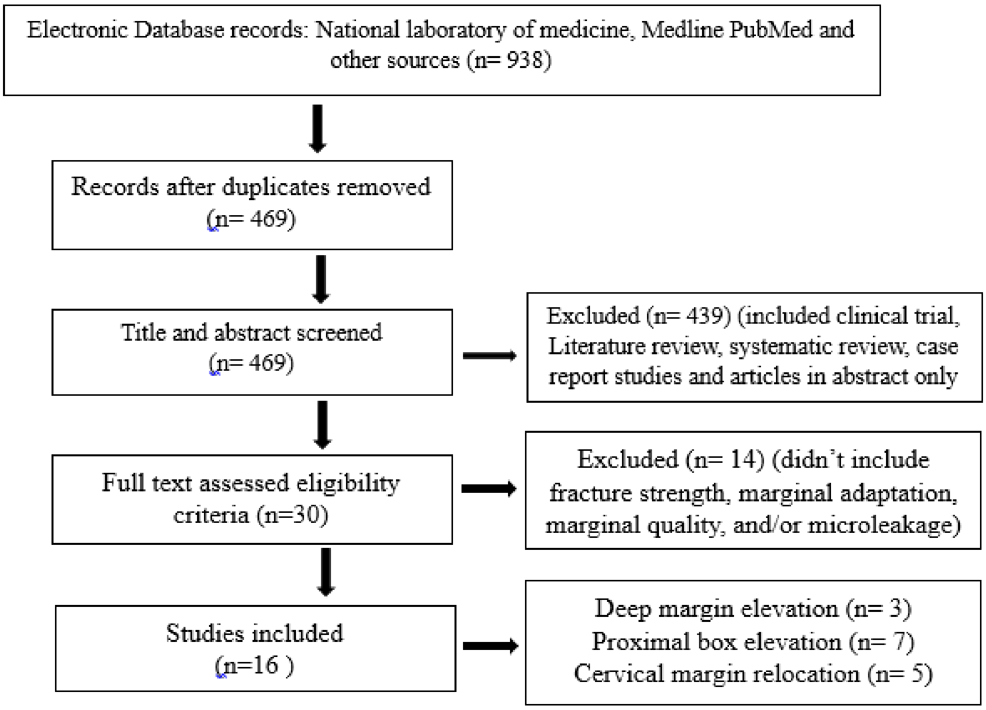

Figure 1: Prisma flow chart

Results

A total of 938 articles were determined by the keywords (deep margin elevation, proximal box elevation, cervical margin relocation) in the National Laboratory of Medicine (PubMed) and Google Scholar. Based on the inclusion and exclusion criteria and after the exclusion of the duplicate studies, 16 articles were included in the present review. Data from the included articles was extracted in a standard form. The form included publication year, type of study, cavity design, test groups, and the main result (Table 1).

Several materials with different thicknesses were used (micro-hybrid, nanohybrid, bulk-filled composites, self-adhesive resin cement, glass ionomers, and resin-modified glass ionomers) to assess the fracture strength, marginal adaptation, marginal quality, and/or microleakage of the definitive restorations. Also, different viscosities of the material are used in one or multiple layers (condensable, flowable, preheated) for the same purpose.

Conventional composite:

Zaruba et al. (2013) studied the effect of DME on the marginal adaptation of MOD ceramic inlay restorations with the proximal margin located in enamel 1 mm above the cementoenamel Junction (CEJ) in one group and 2 mm below the CEJ in the other three groups. With the deep margin groups, the margin was elevated using either one layer (3 mm) or two layers (1.5 mm) of highly filled micro-hybrid composite or remained without DME. It was concluded that the enamel margin group had the best gap-free margins after thermomechanical loading and significantly higher compared to those elevated with micro-hybrid composite. However, the marginal quality of groups with the DME in both layers was not different significantly from bonding directly to dentine.

Frankenberger et al. (2012) and Roggendorf et al. (2013) studied the effect of the resin composite type and the number of applied layers on the marginal quality of a standardized MOD cavity. The deep margin was elevated with different types of self-adhesive resin cement, or by one or three layers of nano-hybrid composite restoration (3 mm and 1 mm, respectively), or left without the DME. It was concluded that direct bonding to dentine produced the least marginal gaps and was not significantly different from those elevated with multiple layers of 1 mm increments of conventional composite. Also, DME with 1 mm increments had significantly better marginal quality than the other groups with DME. Self-adhesive resin cement was not recommended for use as an adhesive with the DME technique.

Lefever et al. (2012) also evaluated the effect of used material in DME with different adhesive systems on the marginal adaptation of 88 extracted molars. Different materials were used in this study; such as self-adhesive resin, flowable, and conventional composite. One of these is the silorane composite, which is a low-shrinkage resin composite with a matrix made of silorane monomers that was polymerized using cationic ring-opening (Ilie and Hickel, 2006). In conclusion, the marginal adaptation of supra-gingivally relocated cervical margins is significantly influenced by the material used and Filtek Silorane provided the highest percentage of continuous margin. (Lefever et al., 2012)

The marginal adaptation and fracture resistance of feldspathic ceramic and composite resin nanoceramic onlay restorations were assessed in another in-vitro study. Two layers of 1 mm hybrid composite material were used to elevate the deep margin or left without marginal elevation. It was shown that DME didn't affect the marginal quality and fracture resistance of feldspathic onlay restorations. However, when compared to ceramic onlay restorations, composite onlay restorations without DME showed higher marginal quality and fracture resistance (Ilgenstein et al., 2015).

Bresser et al. (2020) assessed the impact of DME on the fracture resistance of lithium disilicate inlay and onlay restorations. The deep margin was multiplied by a 2 mm layer of composite or remained without marginal elevation. It was observed that the fracture resistance of ceramic restorations with DME was not significantly different compared to those without DME. However, cuspal coverage with an onlay restoration has higher fracture resistance compared to the inlay restoration.

Flowable composite:

Spreafico et al. (2016) evaluated the impact of the DME on the marginal quality of CAD/CAM crowns fabricated from nanoceramic resin composite and Lithium disilicate. The deep margin was elevated with either a 2-layer conventional or flowable composite (each with 1 mm increments). The tooth has been then restored with indirect restoration. It was concluded that DME did not significantly affect the marginal quality of the test groups.

The marginal sealing of CAD/CAM Cerasmart overlays with DME was assessed in another in-vitro study. The deep margin was elevated with either flowable or micro-hybrid composite in multiplied layers with 1-mm increments or remained without marginal elevation. It was concluded that the marginal sealing no longer substantially affects the leakage rankings between the 2 composite restorations used. However, when bonding directly to dentine, leakage ratings were significantly higher than whilst bonded to enamel (Köken et al., 2018).

Also, the microleakage of direct MOD composite restorations was examined by Zavattini et al. (2018). The deep margin was elevated using either flowable composite, preheated micro-hybrid composite, or micro-hybrid composite. The result confirmed that the flowable composite produced the highest leakage scores at the same time as the preheated composite produced less leakage in comparison to the other groups. So to lessen the chance of microleakage in deep cavities, it is proper to line with preheated composite restoration.

In another study, Scotti et al. (2020) evaluated the interfacial gap using one or more layers of flowable or heavy-flow composite restoration for DME. It was concluded that flowable composite material is at risk of interfacial degradation after thermomechanical loading, especially while applied in a 2-mm-thick layer.

Bulk-fill composite:

Juloski et al. (2018) used a scanning electron microscope (SEM) and a microleakage test to assess the quality of gingival margins produced via the DME technique using different restorative materials. The deep mesial margins have been elevated supra-gingivally either with total-etch adhesive and flowable composite or with universal adhesive and bulk-fill flowable composite. The distal margins remained sub-gingivally as a control group. All samples had been restored with CAD/CAM overlays. The outcomes established decreased microleakage ratings in samples without DME in comparison to those with DME. Also, DME with bulk-fil composite showed lower microleakage rankings in comparison to flowable composite material.

In another in-vitro study, bulk-fill Smart Dentin Replacement and conventional composite material were used to study the impact of DME on endodontically treated premolars covered with ceramic endo-crowns in terms of microleakage and fracture strength. In one group, the margin remained in the enamel 1 mm above the CEJ, while in the other three groups, the deep margin was elevated with either a conventional composite material or two increments of 1.5 mm or one increment of 3 mm bulk-fill SDR. The margins in the last group were left without DME. It was concluded that the highest fracture resistance was in the enamel group, and they were not significantly different from DME with SDR. The fracture resistance was increased significantly in both groups with DME compared to those without DME, and there was no significant difference between both groups with DME. Also, a lower microleakage score was observed in enamel margin groups, and there was no difference between groups with DME (Zhang et al., 2021).

Glass ionomer cement (GIC) and resin-modified glass ionomer cement (RMGI):

In one study the impact of DME with numerous restorative materials on the marginal quality and fracture strength of CAD/CAM resin nanoceramic onlay restorations has been tested. In which the proximal margin was positioned 2 mm under the CEJ on one side and 1 mm above the CEJ on the alternative. The samples were then divided into 5 groups: DME with GIC, RMGI, traditional composite, bulk-fill posterior composite, and the control group without DME. The result confirmed that there has been no substantial difference in the restorative material used on the marginal quality or fracture strength of onlay restorations in all groups. However, the highest fracture strength was shown in a group where the deep margin elevated with Bulk-fill composite compared to the other groups (Grubbs et al., 2020)

The impact of DME with GIC and RMGI on the marginal and structural integrity of CAD/CAM ceramic inlay restorations has been studied by Vertolli et al. (2020). And confirmed that there was no significant difference among the GIC and RMGI groups and that the ceramic fracture rate was decreased in groups with DME.

In a recent in-vitro study, the effect of DME with composite resin and RMGI at the marginal sealing of CAD/CAM ceramic inlay restorations was assessed. The deep margin was elevated by 2 mm with either composite resin or RMGI and the control group was left without marginal elevation. All the samples had been covered with Zirconia-reinforced lithium silicate CAD/CAM ceramic restorations. It was concluded that DME with composite resin restorations and those without marginal elevation had lower microleakage scores than tooth elevated with RMGI (Vichitgomen and Srisawasdi, 2021). In a recent study, Ismail et al. (2022) analyzed the marginal and internal adaptation of numerous restorative materials used for DME. The deep margin was elevated with either RMGI, highly viscous GIC, flowable bulk-fill resin composite, or bioactive ionic resin. The conclusion showed that flowable bulk-fill resin composite and bioactive ionic resin had better marginal integrity than RMGI and GIC.

Discussion:

This review focused on the type of materials utilized for DME regarding their marginal quality, marginal gap, and fracture strength. DME techniques are considered significantly simpler and faster processes and at lower risk of contamination compared to directly luting indirect restoration which is constantly at high risk of contamination and is a more sensitive technique. (Frankenberger et al., 2009; Frankenberger et al., 2013) DME will make it easier to apply the rubber dam for cementing indirect restorations during adhesive procedures and protecting against restoration contamination by saliva, blood, gingival, and crevicular fluid (Zaruba et al., 2013). In addition, DME will contribute to the reduction of the extensive thickness of indirect restoration as excessive thickness could prevent the complete lute curing of the resin cement. (Bresser et al.,2019) Furthermore, in cases when applying the composite increments would have produced extra material, this extra material might be simple to remove while preparing the cavity for an indirect restoration, while it could be difficult to remove any excess material during the cementing of the indirect restoration after polymerization, especially in deep cavities (Frankenberger et al., 2009).

The research discovered that the enamel margin has the best gap-free margins, while a successful layered of 1 mm increment has been important for conventional composites used for DME to reveal lesser gaps in comparison to a single layer with a three mm increment (Roggendorf et al., 2012; Frankenberger et al., 2013). This might be the result of composite resins shrinking during polymerization, which might lead to deboning and resulting in interfacial gaps between the cavity wall and the filler material (Zavattini et al., 2018). Prior research as compared to those without margin elevation found no difference in dentine gap formulation while a couple of layers of a conventional composite of one mm increments were used to raise the deep margin (Frankenberger et al., 2013). Additionally, Zaruba et al. (2013) found that there was no significant difference within the marginal quality when the deep margin multiplied with composite resin in both (3 mm and 1.5 mm) from the ones without deep marginal elevation. Regarding fracture strength, the studies confirmed no significant difference between restorations with and without DME (Bresser et al., 2020).

The low viscosity and ease of application to deep proximal areas of the flowable composite make it a more suitable choice for use in DME. It ensures a closer bond with the cavity walls, produces fewer gaps, and completely wets the bonded floor, allowing for proper adaptation and improving the marginal fit (Attar et al., 2003). However, their problem might be excess and the overhang of the material because of their low viscosity and possible low resistance to deformation under occlusal load (Munck et al., 2005). Additionally, flowable composite material has inferior mechanical properties compared with conventional composite material. So, it is preferred not to be used for DME since they are prone to degradation after thermomechanical loading, particularly when used in a layer of 2 mm thick (Scotti et al., 2020). Also, Zavattini et al. found that flowable composite material produced the highest leakage scores (Zavattini et al., 2018).

Bulk-fill composite could be the most suitable material for DME, because of its ease of placement, increased uniformity, and low instrument pushback. Also, bulk-fill composite has a good depth of cure with a thickness of 4-5 millimeters; this is due to changed initiator methods, polymerization stimulators, new resins, and special fillers (Leprince et al., 2014, Yap et al., 2016). Comparing teeth that have been raised using flowable composite to bulk-fill composite, the authors found that bulk-fill composite had reduced the micro leakage scores (Juloski et al., 2018). Zhang et al. also observed that DME with bulk-fill SDR had higher fracture resistance than conventional composite and that it bonded directly to dentine, which could contribute to enhancing structural support (Zhang et al., 2021).

Researchers suggest using GIC or RMGI for the DME technique, even though resin composite has been used frequently in the research as a direct restorative material in the DME approach with all-ceramic indirect restorations (Grubbs et al., 2020; Vertolli et al., 2020). GIC has certain advantages over resin- composites including chemical adherence to tooth structure, discharge of fluoride, reduced contraction stress, dentine-like elastic modulus, and persistent micro tensile bond strength in moist conditions (Andersson-Wenckert et al., 2002; Schlichting et al., 2011).however, in contrast to resin composite, GIC and RMGI have fewer favorable properties and mechanical characteristics, such as higher solubility rate, less polishable surface, and insufficient bond strength to the tooth surface (Kielbassa and Philipp, 2015). Additionally, a prior study demonstrated that margins elevated with resin composite and those without marginal elevation had lower microleakage scores than those elevated with RMGI (Vichitgomen and Srisawasdi, 2021). For all previous studies, GIC and RMGI are not recommended as a material of choice to be used with the DME technique.

Accordingly, there is limited data available from the published clinical trials and in vitro studies, and they failed to name the gold standard material that can be considered for comparison. Additional carefully planned clinical trials are therefore required to support the results.

Conclusion:

Although the DME technique makes it easier to place indirect restorations in clinical practice, there has been controversy about the suitable material and approach used with this technique. Based on in-vitro studies, it is recommended to apply the DME technique in multiple layers of 1 mm increment using traditional composite material or bulk-fill composite material. This will decrease the polymerization shrinkage and consequently the marginal leakage. Flowable composite material, glass ionomer cement, resin-modified glass ionomer cement, and self-adhesive resin cement are not recommended to be used with the DME technique due to their low mechanical properties.

Conflict of interest

The authors reported that they have no conflicts of interest.

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Table (1): Details of the included studies

Authors and Publication Year	Type of Study	Cavity design	The test groups	Main Result
Zaruba et al., 2012	Marginal adaptation	Class II MOD-cavities, in one group the proximal margins were located 1 mm above the CEJ (enamel margin), while 2 mm below in the other three groups	Molar (N:40) is divided into four groups (N:10): (1) margin in enamel, (2) DME in one layer of Tetric Composite (3mm), (3) DME in two layers of Tetric Composite (1.5mm), (4) without DME.	The composite–enamel interface showed the most gap-free margins. Marginal quality in DME was not significantly different from bonding directly to dentin.
Roggendorf et al,, 2012	marginal quality	MOD cavities with one proximal box beneath the cementoenamel junction were prepared in 40 extracted human	Third molars (N:40) are divided into five groups: (1) DME with G-Cem, (2) DME with Maxcem, (3) DME in one layer of Clearfil Majesty Posterior, (4) DME in three layers of Clearfil Majesty Posterior, (5) without DME.	Bonding directly to dentine produces better marginal quality than the other groups and is similar to that of three layers (1 mm) marginal elevation with resin composite. Self-adhesive resin cement is not recommended as a restorative material for DME.
Frankenberger et al., 2012	Marginal quality	MOD cavities with one proximal the box beneath the cementoenamel junction was prepared	The third molar (N:48) is divided into six groups (N:8): 3mm (1) DME with RelyX Unicem, (2) DME with G Cem, (3) DME with Maxcem Elite, (4) DME in one layer of Clearfil Majesty Posterior, (5) DME in three layers of Clearfil Majesty Posterior, (6) without DME.	Bonding directly to dentine yielded the fewest gaps. Marginal quality with three-layer DME was superior compared to one layer. Self-adhesive resin cement as elevation material is not indicated for DME.
Lefever et al., 2012	Marginal adaptation	A standardized box shape was prepared on each tooth with the cervical margin 1.3 mm below the CEJ	Extracted molars (N: 88) divided into eight groups using different elevation materials (Filtek Silorane, Clearfil AP-X, Clearfil Majesty Posterior, Clearfil Majesty Flow, RelyX Unicem, SDR, Vertise	Marginal adaptation was material-dependent.

			Flow) combined with different adhesive systems (Filtek Silorane Primer and Bond, Clearfil Protect Bond, Filtek Silorane Bond).	
Ilgenstein et al., 2015	Marginal integrity/fracture behavior	Standardized MOD cavities were prepared with the distal box located 2 mm below the CEJ.	mandibular molars (N:48) divided into Four groups: (N:12): (1) without DME/feldspathic ceramic, (2) DME/feldspathic, (3) without DME/resin nanoceramic, (4) DME/resin nanoceramic.	DME did not affect fracture resistance. Nor the marginal integrity of feldspathic onlays. Resin nano-ceramics were superior to feldspathic, especially in specimens without DME.
Bresser et al., 2020	Fracture strength	Standardized MOD cavities were prepared with the proximal boxes located 2 mm below the CEJ	Molars (N:60) divided into 4 groups (N:15): (1) inlay without DME, (2) inlay with DME, (3) onlay without DME, (4) only with DME).	DME did not affect the fracture strength, nor the fracture type of lithium silicate restorations in molars. However, Cuspal coverage did increase the fracture strength
Spreafico et al., 2016	Marginal quality	Standardized crown preparation was prepared, the margin on the mesial side located at 2 mm, while on the distal side of the tooth, the margins were located 1 mm above the CEJ	Molars (N:40) divided into 4 groups (N:10) (1) DME with 2-layer conventional composite/ IPS e.max, (2) DME with 2-layer conventional composite/lava Ultimate, (3) DME with 2-layer flowable composite / IPS e.max, (4) DME with 2-layer flowable composite/lava Ultimate.	They concluded that DME did not affect the marginal quality in any of the test groups
Köken et al., 2018	Marginal sealing	Standardized MOD cavities prepared with the proximal margins on the mesial side located 1 mm below the CEJ. On the distal side of the tooth, the margins were located 1 mm above the CEJ	Human molars (N:39) are divided into three groups (1) DME with GC Essentia MD, (2) DME with GC Gaenial Universal Flo, (3) without DME.	Micro-hybrid and flowable composites are comparable in terms of marginal sealing ability. However, leakage scores were significantly lower when bonding directly to dentin.

Zavattini et al., 2018	Microleakage	Class II cavities were prepared with the proximal box located 1.5 mm apical to the CEJ and distally located 1.5 mm coronally to the CEJ.	Molars (N:30) are divided into three groups, DME was relocated using either a micro‑hybrid, preheated, or flowable composite, and restorations were then completed using a conventional composite.	Flowable composite yielded the highest leakage scores.
Grubbs et al., 2020	Marginal quality/ fracture resistance	a standard MOD cavity with mesial cervical margins located 1 mm above the CEJ and distal cervical margins located 2 mm below the CEJ, all covered with (CAD-CAM) resin, nanoceramic onlay	Molars (N:75) are divided into five groups (N:15): (1) DME with GIC, (2) DME with RMGIC, (3) DME with composite Supreme Ultra, (4) DME with Filtek bulk fill posterior restorative, (5) without DME.	All materials tested did not affect the marginal quality nor fracture resistance of the restorations
Scotti et al.,	Interfacial gaps	Standardized class II cavities were performed with the mesial margin located 1 mm above CEJ and the distal margin 1 mm below the CEJ.	Maxillary premolars (N:48) are divided into six groups (1) DME in one layer of heavy flow + nano filled composite, (2) DME in one layer of flowable+ nano filled composite, (3) Like (1) in two layers, (4) Like (2) in two layers, (5) restoration with nanohybrid composite without DME, (6) restoration with bulk-fill nano filled composite without DME).	They concluded that flowable composites are prone to interfacial degradation after thermomechanical loading, especially when applied in a 2-mm-thick layer
Juloski et al., 2020	Marginal quality	Standardized MOD cavities with the proximal margins in both, mesial and distal sides, were located in dentin, approximately 1 mm below CEJ.	Deep mesial margins were elevated supragingivally with either (1) total-etch adhesive and flowable composite or (2) universal adhesive and bulk-fill flowable composite, Distal margins were not elevated.	The results demonstrated lower microleakage scores at margins without DME compared to groups with DME, and lower microleakage scores in teeth elevated with bulk-fil composite compared to those elevated with

				flowable composite
Vertolli et al., 2020	Structural/ marginal integrity	Standardized Cl II was prepared with the cervical margin placed 2 mm below the CEJ, except for the enamel margin group where the cervical margin remained 1 mm above the CEJ on the enamel tooth structure	Third molars (N:40) are divided into four Groups (10): (1) margin in enamel, (2) margin in cementum, (3) DME with GI, (4) DME with RMGI.	DME led to decreased ceramic fracture rates. No difference was identified among the GIC and RMGIC groups.
Zhang et al., 2021	Fracture resistance/ microleakage	Standardized MO cavities with the cervical margins were set 2 mm below CEJ	RCT premolars (N:80) divided into four groups (N:20): (1) margin in enamel, (2) DME with bulk-fill composite, (3) DME with conventional composite, (4) without DME. All covered with endocrown	DME increased fracture resistance of premolar endo-crowns but not microleakage.
Vichitgomen et al., 2021	Marginal sealing	Standardized Class II cavities were prepared with the proximal margin located 1 mm below the CEJ.	Molars (N:30) are divided into three groups: (1) without DME, (2) DME with resin composite (3)DME with RMGI.	They conclude that teeth elevated with RMGI have higher microleakage scores compared to those elevated with resin composite and those without marginal elevation
Ismail et al., 2022	marginal and internal adaptation	Standardized class II cavities were prepared with the cervical margin located 2 mm below CEJ	Molar (N:56) divided into four groups with the deep margin elevated with either RMGI, highly viscous GIC, flowable bulk-fill resin composite (Bulk Flow) or bioactive ionic resin (Activa)	They concluded that flowable bulk-fill resin composite and bioactive ionic resin have had better marginal integrity than RMGI and GIC.