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Newer Possibilities for Proximal Box Elevation – Tooth Substrate and Comparison with Conventional Materials: An *Ex-vivo* Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Adhesive bonding in deep sub-gingival areas is a challenge due moist environment leading to poor marginal seal and microleakage in deep class II cavities. The deep margin elevation technique is advocated in such areas.
Aim: The aim of this study is to evaluate enamel, a natural substrate as an alternative material for deep margin elevation, and compare it with the resin-modified glass ionomer and composite material by evaluating microleakage at the tooth-restoration interface in Class II cavities.

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Materials and Methods: For this study 21 patients having at least one tooth indicated for extraction and 7 patients having at least two teeth indicated for extraction were included.Class II cavities were prepared on the 28 teeth with proximal margins 1mm below the CEJ and were divided into 4 groups(n=7) Group 1: flowable composite was used for deep margin elevation(DME) up till 2mm above CEJ, Group 2: RMGIC was used for DMEup till 2 mm above CEJ, Group 3: enamel slab luted with RMGIC (for DME)up till 2mm above CEJ,enamel slab obtained from other seven teeth of same patient also indicated for extraction, Group 4(control): no intermediate material was used for margin elevation. Then the remaining part of the cavities were restored using the FILTEK P60. The prepared teeth were extracted after one week. The class II cavities were evaluated for microleakage using dye penetration method.

Results: RMGIC and enamel slab showed significantly less microleakage as compared to flowable composite and the control group. However there was insignificant difference between RMGIC and Enamel slab group. The control group exhibited highest microleakage as compared to all the other groups.

Conclusion: RMGIC and enamel slab exhibit least microleakage when used as materials for deep-margin elevation.

Keywords: Deep margin elevation; resin modified glass ionomer cement; composite; enamel slab.

1. INTRODUCTION

Achieving adequate isolation in the moist deep subgingivalareas is one of the most common yet challenging experiences faced in restorative dentistry. This poses challenge in adhesive bonding in these areas,thereby leading to poor marginal seal and microleakage at the restoration tooth interface.

The conventional approach to accessing the sub-gingival margins include orthodontic extrusion, surgical exposure of thecervical margin, or a combination of both techniques leading to an apical displacementof supporting tissues to access the subgingival margin and obtain adequate space for theestablishment of biological width (BW).Often, these methods may cause exposure of furcationsand root concavities tothe oral environment, leading to further attachment loss, dentin hypersensitivity and compromised esthetics. Additionally, this process may delay the delivery of thefinal restoration.

An alternative approach was proposed in 1998 by Dietschi and Spreafico [1] called “deep margin elevation” (DME) also referred to as “cervical margin relocation”, “proximal box elevation”,and “coronal margin relocation”, where a base of composite resin is applied over the pre-existing cervical margin to relocateit coronally. The widely used “open sandwich technique” for restoring deep cervical lesions can be considered as a predecessor of DME [2]. Cervical margin relocation affords several advantages over the conventional methods, i.e., avoidance of unnecessary tissue sacrifice, timely delivery of the final restoration to the patient, adequate moisture control,facilitation in impression taking,proper bonding procedures, and removal of excess cement.

The elevation of proximal dentin margins under direct or indirect restorations has been investigated using either glass ionomer -based or resin-based materials.The disadvantage of resin-based materials is polymerization shrinkage as bonding to dentin is a challenge due to higher proportion of water and organic matter in its composition as compared to enamel [3]. Beznos [4] concluded that “when the cervical margin in class II cavities is located on enamel, different direct restorative techniques demonstrated a good seal. However, when located in dentin, they all failed to do so”.

Using enamel, a natural substrate as a substitute for dentin could be a possible alternative as it is mainly an inorganic tissue that contains only small amounts of water and organic substances. In (1991) Santos and Bianchii [5] used the technique of bonding sterile tooth dental fragments to teeth with large coronal destruction. The term “Biological Restoration” was used to describe an alternative technique that uses adhesive capabilities of materials in combination with strategic placement of parts of extracted human permanent teeth to achieve better aesthetics and more conservation of sound dental tissues.

The research in the field of biological restorations is still lacking. This study aims to evaluate enamel, a natural substrate as an alternative material for deep margin elevation and compare

it with the resin modified glass ionomer and composite material by evaluating microleakage at the tooth-restoration interface in Class II cavities.

2. MATERIALS AND METHODS

This study was done in the Department of Conservative Dentistry and Endodontics, Sri Guru Ram Das Institute of Dental Sciences and Research, Sri Amritsar.

Out of all the patients reporting to the Department of Oral and MaxillofacialSurgery,21 patients having at least one tooth indicated for extraction and 7 patients having at least two teeth indicated for extraction due to prosthodontic or orthodontic reasons were selected based on the following inclusion and exclusion criteria for the teeth to be extracted.

Inclusion criteria included non-carious permanent teeth whereas exclusion criteria included teeth with developmental defects, visible cracks, fractures,previous root canal treatment, or any malformations.

2.1 Procedure

On all the selected teeth a Class II cavity was prepared using aNo. 245 carbide bur, with a high-speed air rotor handpiece.The occlusalpreparation extended3-mm bucco-lingually with3-mm pulpal depth. The proximal box preparation extended 1 mm below the CEJ, the mesiodistalwidth of the proximal box was 1.5mm, and the bucco-lingual widthwas3mm. The patients were randomly divided into 4 groups depending upon the material used for elevation of the deep gingival margin with 7 patients in each group.

Group 1: Flowable composite (Meta Biomed) was placedgingivally after one coat application of universal self etch adhesive(Scotch bond universal 3M ESPE) on gingival seat of the proximal box of the class II cavity in order to elevate the proximal margin to 1mm above the CEJusing modified matrix technique. The rest of the cavity was restored with Resin composite Filtek p60 (3M ESPE).

Group 2: Resin Modified GIC (GC Gold Label II LC) was placedgingivally after the application of a coat of universal adhesive(Scotch bond universal 3M ESPE) on gingival seat in order to elevate the proximal margin to 1mm above the CEJ using the modified matrix technique.The rest of the cavity was restored with Resin composite Filtek p60 (3M ESPE).

Group 3: Enamel slab of dimensions same as of the floor of the proximal box and thickness of approximately 2mm luted with Universal self etch adhesive and RMGIC(GC Gold Label 2 LC ,GC corporation) to the gingival margin of the proximal box of the class II cavity in order to elevate the proximal margin to 1mm above the CEJ. An Enamel slab was taken from another tooth of the same patient using a double-sidecoated disc, finished with Arkansas stone. The rest of the cavity was restored with Resin composite Filtek p60 (3M ESPE).

Group 4 (Control): A coat of Universal adhesive(Scotch bond universal 3M ESPE) was applied and then the cavities were restored using P 60 micro-hybridcomposite. No material was used for deep-margin elevation.

S. No.	Material for DME	Material for restoration
Group 1	flowable composite (Meta Biomed)	Filtek p60 (3M ESPE)
Group 2	RMGIC(GC Gold Label II LC, GC Corp., Japan)	Filtek p60 (3M ESPE)
Group 3	Enamel slab luted with RMGIC(GC Gold Label II LC, GC Corp., Japan)	Filtek p60 (3M ESPE)
Group 4	No material for DME	Filtek p60 (3M ESPE)

Patients were recalled after 1 week for extraction of restored tooth.After cleaning, washing & drying the extracted tooth 2 coats of nail varnish wereapplied on tooth surface leaving a 1mm border around the restorative margins then the samples will be placed in methylene blue dye for 24 hours. After removal of the specimens from the dye, the surface adhering dye will be rinsed in tap water to remove extra dye collected and air dried. Sectioning was done along mesiodistal direction with double sided disc .Specimens were dried and viewed under Stereomicroscopeandmicroleakage was evaluatedaccording to following scale [6].

Score 0 = no dye penetration,
Score1 =dye penetration up to 1/3rd cavity depth,
Score2 =dye penetration 1/3rd to 2/3rd cavity depth,
Score3 = dye penetration in excess of 2/3rd cavity depth
Score4 =extensive penetration involving the axial wall.

The scores obtained were put on statistical analysis using Post Hoc Bonferroni test.

3. RESULTS

The mean values of microleakage for group 1, 2, 3, 4 were 3, 1.857, 1.714 and 3.857 respectively (Table 1). Maximum microleakage was observed with group 4 (control group) followed by group 1 (flowable composite) and then, group 3 and group 2 which were enamel slab and RMGIC respectively. Using post hoc bonferroni test it was observed there was statistically significant difference between all groups except group 2 and group 3 (Table 2). Thereby showing that there was no significant difference in microleakage when RMGIC and enamel slab were used for deep margin elevation.

4. DISCUSSION

In this study the deep margins of class II cavities were elevated for evaluation ofmicroleakageusingnatural tooth substrate (enamel),flowable composite along with Universal self etch adhesive and resin modified Glass Ionomer cement with Universal self etch adhesive.

Universal adhesives are the latest generation of adhesive systems and are less technique sensitive. In addition, the application of universal adhesive to dentin reduces the risk of excessive etching [7]. In our study we used universal adhesive as it shows higher bond strength with RMGIC and Composite [8].

Flowable composites were used since they adapt well to the tooth and seal the interface due their low viscosity and better flow. They are easy to manipulate and hence can be placed in the deep cervical areas. Dietschi et al. [1] concluded that “flowable composite acts as a stress-absorbing layer. This could be justified by the idea of an elastic wall, which is based on the low modulus of elasticity and the high wettability of flowable materials”.

GICshavethe advantage of being biocompatible, fluoride-releasing, and have chemical adhesion to teeth without the need for bonding agents. But the disadvantage of conventional GICs is the lack of sufficient strength and toughness and their sensitivity to moisture contamination. In order to improve the mechanical properties of conventional GIC, resin-modified glass-ionomers (RMGICs) were introduced. RMGIC showed less microleakage than the conventional GIC [9]. Moreover, in RMGIC the initial setting reaction is triggered by the light, which is followed by an acid-base reaction after the absorption of water leads to the “Umbrella effect”.We chose RMGIC (GC Gold Label II LC).

In this study, we replaced dentin/ cementum with natural substrate i.e. enamel. Regardless of depth or where it is located, enamel has a crystal, homogeneous structure mostly formed by hydroxyapatite. Conversely, dentin is a vital organic substrate, inherently hydrated and heterogeneous, which makes adhesive procedures more complex. Therefore, bonding to enamel is more predictable than bonding to dentin.

In the present study, 1% methylene blue dye is used as it is considered an easy, relatively inexpensive, and comparable method. The dye penetration method requires an adequate evaluation tool to determine the true extent of microleakage. We used the stereomicroscope as an aid to evaluate the true extent of microleakage.

The Enamel slab showed significantly less microleakage as compared to the flowable composite and control group when used as substrate for deep margin elevation. This could be attributed to better bonding to enamel as compared to dentin. Enamel consists of 96% by weight inorganic substance and dentin contains 65% by weight inorganic substance [10].The significant removal of calcium and phosphate from hydroxyapatite afteretching allows resin infiltration and strongbonds are formed with enamel whereas indentinlesser inorganic content and the presence ofdentinal fluidmake bonding difficult. Loguercioetal, [11] concluded that Resin-dentin/ cementum bonds are less durable than resin-enamel bonds.

In our study RMGIC showed significantly less microleakage as compared to flowable composite when used for deep margin elevation. Similar results were reported by Kasraei

Table 1. Mean value of microleakage amongst different groups

Groups	Mean	Standard Deviation
Group1	3	0.577
Group2	1.857	0.377
Group3	1.714	0.487
Group4	3.857	0.377

Table 2. Inter group comparison Post hocbonferroni test

Comparison	p-value (Post-Hoc Test)	Difference
Group 1 vs 2	0.000893505	Significant
Group 1 vs 3	0.000726653	Significant
Group 1 vs 4	0.006503325	Significant
Group 2 vs 3	0.551719095	**Non-Significant**
Group 2 vs 4	0.0000003.99	Significant
Group 3 vs 4	0.0000008.89	Significant

Significant p value <0.05

et al. [12]. who evaluated “microleakage at the occlusal and gingival margins of Class II cavities and reported that resin-modified glass-ionomer liner demonstrated significantly less leakage than flowablecomposite”. Aggarwal V et al. [13] reported that a 41% reduction in the volumetric contraction of resin composite restorations was obtained when lined with RMGIC. On the contrary, Gowda et al. [14] evaluated “flowable composite and resin-modified glass ionomer (RMGI) in terms of microleakage and found that specimens with flowable composite liner showed statistically better seal compared to RMGIC liner group and contributed their results to the fact that there are minimal internal porosities incorporated within the material”.

In the control group, the highest microleakage was observed when only composite resin was used without any material to elevate the margin. The higher viscosity of this packable resin composite as compared to flowable composite hinders its placement in the deep cervical margins and also lesser polymerization contraction forces exhibited by RMGIC as compared to flowable composite(Casteneda-espinoza JC et al.) [15] couldexplain this observation.

There was an insignificant difference in microleakage between RMGIC and enamel slab when used for proximal box elevation. Research using enamel substrate as an alternate to conventionally used materials for proximal box elevation is lacking. Enamel being a material with a better compressive strength seems to be a more promising alternative and should be evaluated for further research.

5. CONCLUSION

In deep class II cavities deep margin elevation using an intermittent material should be performed in order to reduce microleakage. RMGIC and enamel slab exhibit least microleakage when used as materials for deep-margin elevation. Further studies using enamel substrate for deep margin elevation in deep class II cavities should be carried out.

ETHICAL APPROVAL AND CONSENT

Ethical clearance as per university rules and standards was obtained. From all the patients included in this study written consent was collected and preserved.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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