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A Randomized In Vitro Comparison Of Marginal Sealing Ability Of Self-Adhering Composite In Absence/ Presence Of Eugenol

[1]Dr. Shalini Rai, Lecturer, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University, UP, India

[2]Dr. Vineeta Nikhil, M.D.S., Dean Clinical Affairs, Director PG Studies and Head, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University, UP, India

[3]Dr.Padmanabh Jha, M.D.S., Professor, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University, UP, India

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Corresponding Author: Dr. Shalini Rai, Lecturer, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University, UP, India

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Abstract

Objectives

To evaluate the effect of eugenol-based temporary on marginal sealing ability of self-adhering composite at 24hrs and 7days time intervals.

Material and Methods

128Class V cavities were prepared on 32 freshly extracted molars. Cavities were randomly divided into four groups. Group 1: IRM temporization and self-adhering composite (SAC); Group 2: IRM temporization, self-etch adhesives and Nanohybrid composite; Group 3: Cavit temporization and self-adhering composite (SAC) and Group 4: Cavit temporization, self-etch adhesives and Nanohybrid composite. Each group was divided into two subgroups, A-24 hrs and B-7 days. Samples were thermocycled and immersed in 1% methylene blue. Samples were sectioned and evaluated under stereomicroscope.

Statistical Analysis

Kruskal-Wallis and Mann-Whitney test were used for analysis.

Result

Mean leakage scores at the enamel and dentin margin was Group 4A = 4B < 2B < 2A <3A < 3B < 1B < 1A.

Conclusion

Presence of eugenol at early stage i.e. 24hrs, has a negative influence on sealing ability of SAC. At 7 days, the negative effect of eugenol on marginal sealing ability get nullified. Thus, a waiting period of one week is sufficient to overcome negative influence of eugenol-based temporaries on polymerization of SAC.

Key words

Cavit, Eugenol, IRM, microleakage, sealing ability, self-adhering composite, self-etch adhesive.

Introduction:

Bonding of dental composite resins to dental hard tissues gets affected by the adhesion strategy, adhesive layer thickness, structure of substrate and type of utilized provisional restorative material.[1]

Acid etching and rinsing is not required in nowadays popular self-etching adhesive systems, due to their acidic primers making them lesser technique sensitive compared to etch and rinse system. Therefore, in adhesion process the modified smear layer is incorporated.[2]

Zinc oxide eugenol (ZOE) temporary sealing material in restorative dentistry has a radical scavenger, eugenol that inhibits polymerization of resin.

Temporary are difficult to be remove completely. In addition, small bit of eugenol is released from ZOE cement, which eventually contaminates the dentin surface by penetrating the dentinal tubules.[2] All these can affect the adhesion, wetting capability and sealing ability of the adhesive system. However, the results of effect of eugenol on composite resin sealing are inconclusive.[3]

A new self-adhering composite (SAC), Dyad Flow has received the most attention in recent years as it can be bonded to dental tissue without application of any other adhesive system. In these composites, glycerol-phosphate dimethacrylate (GPDM), which is an acidic monomer that can etch both enamel and dentin, has been used.[4]

Studies[2,5,6,7]have been done to evaluate the marginal sealing ability of SAC, however, there is no research done to best of our knowledge in which influence of eugenol on SAC has been evaluated.

Thus, this study aimed to evaluate the effect of eugenol on marginal sealing ability of SAC at different time interval. The null hypothesis to be tested was that there is no influence of eugenol and duration of application time on the marginal sealing ability of SAC.

Materials and Methods

Non-carious, extracted, human permanent molars teeth, free of previous restorations, or structural deformities were collected and evaluated for absence of fracture lines under dental surgical microscope. 32 teeth were selected and stored in 1% Chloramines T solution at 4°C until use.

Standardized Class V tooth preparation (Depth 2mm, Length 2mm and Width 4mm) was done on mesial, distal, facial and lingual/palatal sides of all molars with high speed tapered fissure carbide bur (#701) under air-water cooling. The cervical margin of cavity was located below CEJ in dentin.

Each surface was assigned for different group on the basis of temporization and restorative material used:

Group 1(Mesial)

ZOE cement (IRM) + SAC (Dyad Flow).

Group 2(Distal)

IRM + Selective etching (SL etchant gel, Coltene) + self-etch adhesive (One Coat 7 Universal, Coltene) + Nanohybrid Composite (Herculite Precis, Kerr).

Group 3 (Facial)

Eugenol-free temporary cement (Cavit) + SAC.

Group 4 (Lingual/Palatal)

Cavit + Selective etching + self-etch adhesive + Nanohybrid Composite.

After the temporization of cavities with IRM/Cavit, each group was divided into two subgroups on the basis of time period for which temporary cement was retained, subgroup-A, for 24 hours and subgroup-B for 7 days. Temporary cement was removed with a ultrasonic scaler and cavity was cleaned with pumice-water slurry in a slow- speed handpiece for 1 min.

The cavity immediately received respective restorative materials. Dyad Flow was restored as per manufacturer instruction ingroup 1 and 3. In groups 2 and 4, enamel of cavity was etched for 15 seconds, rinsed and dried. One coat 7 Universal was applied to cavity walls and light cured as per manufacturer instructions. The cavity was then restored with "nanohybrid" composite (Herculite precis) using 1mm thick incremental technique.

The samples were thermocycled (5°C, 37°C and 55°C) water bath with a transfer time of 15 s and a dwell time of 30 s between each cycle for 5000 cycles. Nail paint were applied on entire sample surface except for the restoration and 1-mm area beyond the margins. Further, samples were immersed in 1% methylene blue dye for 30 min. Thereafter, were washed, dried and nail paint was removed. From the centre of the restorations samples were sectioned mesiodistally and buccolingually and evaluated under stereomicroscope for scoring using ISO/TS 11405:2003.[8]

Microleakage Scores

0 = No dye penetration,1 = Dye penetration not more than half of the occlusal/cervical wall, 2 = Dye penetration more than half of the occlusal/cervical wall, 3 = Dye penetration along axial wall.

Data were collected and analysed using IBM Statistical Package for Social Sciences version 19

Result

The mean dye leakage scores in different groups are shown in fig 1. Ranking of mean leakage scores at the enamel and dentin margin was Group 4A = 4B < 2B < 2A <3A < 3B < 1B < 1A. At both enamel and dentin margin, the microleakage associated with Group 1A was significantly greater than for all the groups. The frequency distribution of dye penetration scores at the enamel-restoration and dentin-restoration interfaces is shown in figure 2 and 3. Result of Kruskal-Wallis and Mann-Whitney statistical analysis are shown in Table 1.

Discussion

One of the most important aims of cavity restorations is to establish predictable marginal seal in order to prevent microleakage and its clinical consequences such as marginal discrepancies, marginal staining, recurrent caries, sensitivity and pain.[9,10]Failure is usually seen where margins are in dentin due to poor adhesion between bonding agent and dentin.

SACs combine the merits of both restorative material and adhesive technologies in one product, as it is a direct composite resin restorative material that has an adhesive resin together with a flowable composite resin. Therefore, this composite could lessen clinical application time and significantly reduce technique sensitivity during application and manipulation[11,12]which is a boon when doing sub gingival preparation as in this study.

To mimic cyclic temperature changes in oral conditions samples were thermocycled.Dye penetration is an established *in vitro* method for investigating marginal leakage along tooth-restoration interfaces.[13-15] Ernst *et al*.[13] found a correlation between methylene blue 30-min immersion and SEM analysis, particularly for enamel margins. Thus, for 30min at 37°C, 1% methylene

blue was used for marginal spaces marking in the present study.

Both the interfaces enamel-restoration and dentin-restoration, showed infiltration, however, infiltration differed in relation to the material and the substrate. The infiltration at enamel-restoration was significantly lower than that on dentin-restoration interface (p=0.00). This result is in accordance to Sadeghi *et al*,[16]Wibowo*et al*,[17]Ozel*et al*,[18] Scotti *et al*,[19] and Vagarali*et al*[20]where increased marginal leakage was observed when the cervical margin was located below the CEJ. Even the marginal sealing ability of SACs and self-etch adhesive at cervical margin was observed significantly lower (p=0.000 and 0.002 respectively) irrespective of the type of temporary cement used. Mann *et al.*[21] similarly found that SACs showed greater leakage at the cervical margin. Probably due to complex, organic rich, tubular structure and lower surface energy of dentin as compared to enamel would have caused inferior adhesion.[108]However, eugenol containing temporary groups showed more leakage at both the margins than non-eugenol temporary groups. Azevedo *et al.*[3]also concluded same finding and explained that eugenol can leach through the smear layer achieving the dentin tubules and contaminating the dentin surface. Eugenol residues present at the smear layer, would inhibit monomer polymerization. A hybrid layer with a large amount of unreacted monomers is more permeable to the dye tracer used in microleakage analysis. Better results on enamel-restoration interface can be attributed to the minutest enamel permeability due to highly mineralized nature of enamel and the thinnest smear layer formed in this substrate[3] thus holding less eugenol to interfere with adhesive polymerization.

In clinical scenario the distance of light source from the material especially at the gingival floor as compared to occlusal surfaces might further increased gingival microleakage when compared to occlusal.

In the present study, at cervical level the marginal sealing ability of SACs after 7 days of IRM retention was significantly (p=0.035) more than after 24hrs. Same type of result was also observed for self-etch adhesives, with Nanohybrid composite. This is in accordance to the observations drawn by Yap *et al.*[22]and Hume *et al.*[23]in their study. The reason for the low marginal sealing ability after 24hrs may be due to the high release of eugenol, which occurs in the first hours of contact with moisture may be responsible for the reduction of marginal sealing ability of SACs. Diffusion rate of eugenol highest at one day and decrease rapidly after one week. The presence of water in the oral medium as well as dentinal tubules may favour a reversible reaction of liberating eugenol from the zinceugenolate matrix, which is incorporated into the subjacent dentin. These characteristics favour the accumulation of free non-reacted eugenol in the smear layer and dentinal tubules, these eugenol molecules would bond to the free radical, postponing resin polymerization and compromising the bond strength of adhesive systems.

At occlusal level, When the marginal sealing ability of SACs done after 7days of IRM retention was compared with the restoration done after 24hrs.The difference in the marginal sealing ability was statistically insignificant (p=0.278). Same type of result was also observed for self-etch adhesives, with Nanohybrid composite and at occlusal level (p=0.624). This can be attributed to the smallest enamel permeability as enamel is highly mineralized and the thinnest smear layer formed in this substrate, thus retaining less eugenol to interfere with adhesive polymerization even when restoration was done after 24hrs thus the influence of eugenol was negligible.

In general, in the present study the marginal sealing ability of self-etch adhesives was superior than SACs. This is in accordance to the study result of Mann *et al*.[21] The reason for better performance of self-etch may be that, this adhesive contains the functional monomer 10-Methacryloyloxydecyl dihydrogen phosphate (10-MDP), which enables an intensive and stable chemical bond with hydroxyapatite.Such primary chemical interaction improves the resistance to hydrolytic breakdown, and thus, clinically keeps the restoration margins sealed for a longer period.

At occlusal level, When the marginal sealing ability of SACs done after 24hrs and 7days of IRM retention was compared with the marginal sealing ability of restoration done by SACs after 24hrs and 7 days of non-eugenol based temporary retention. The marginal sealing ability was statistically insignificant (p=0.061 and 0.987) respectively. This is in accordance to the study result of Yap *et al.*[22] and Peutzfeldt*et al*.[24] found that there is no significant difference in use of low concentration of eugenol and non-eugenol temporary group.

At cervical level, when the marginal sealing ability of SACs done after 7days of IRM retention was compared with SACs after 7 days of Cavit retention, the difference was statistically insignificant (p=0.198). Similarly, at both occlusal and cervical level, after 7 days of retention of IRM when compared with 7 days of Cavit retention in self-etch adhesives, the marginal sealing ability was statistically insignificant (p=0.644 and 0.317). This may be due to dilution of effect of eugenol by one week period. This finding has a clinical importance that if a eugenol based temporary restoration has been done a waiting period of one week is sufficient to overcome negative influence of eugenol on polymerization of composite.

Further in vitro study with more close adaptation of oral environment and larger sample size and other period of exposure between 24hrs and 7 days should be carried out in addition to *in vivo* study to validate these results and for stronger evidence of eugenol containing temporary cements on marginal sealing under controls variables.

Conclusion

Within the limitations of the present study, it is possible to conclude that -

The marginal sealing ability of self-etch adhesives is better than SACs. Presence of eugenol, at early stage i.e. 24hrs has a negative influence on bonding thus sealing ability of composites. At 7 days, the negative effect of eugenol on marginal sealing ability of composites get nullified. Thus, on the basis of observations in present study it can be recommended that if ZOE based temporary is used, a minimum of 7 days waiting period is required for permanent restoration for nullifying the negative effect of eugenol on marginal sealing ability of composites. Negative effect of eugenol was on marginal sealing ability was dependent on amount of eugenol freely available. Thus, mixing of cement should be done as per manufacturer proposed proportions.

Figure Legends

Table 1: Result of Statistical Analysis.

Fig 1: Comparison of microleakage scores of occlusal and cervical margins among different groups.

Fig 2: Frequency distribution of enamel dye penetration scores.

Fig 3: Frequency distribution of dentin dye penetration scores

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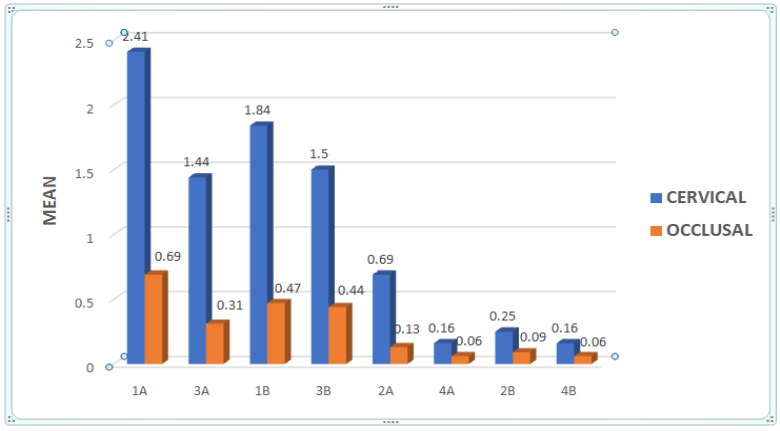

Fig 1: Comparison of microleakage scores of occlusal and cervical margins among different groups.

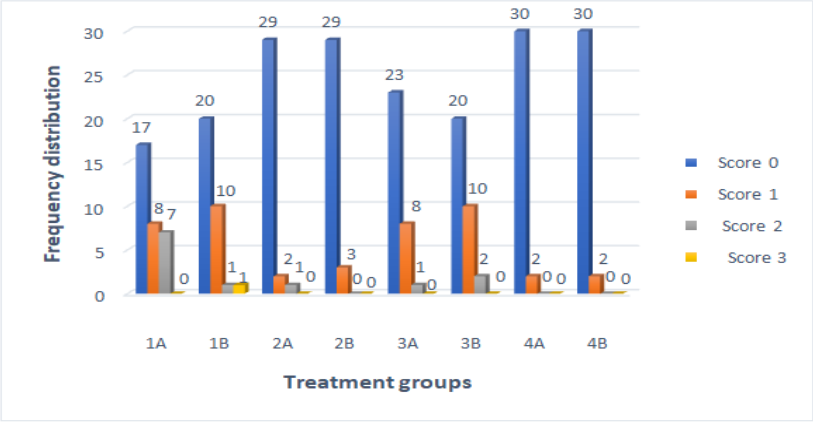

Fig 2: Frequency distribution of enamel dye penetration scores.

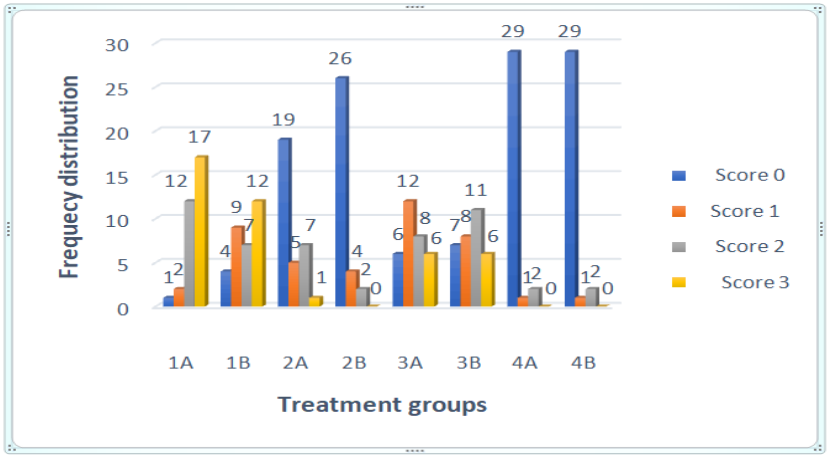

Fig 3: Frequency distribution of dentin dye penetration scores

Table 1: Result of Statistical Analysis.

Comparison between treatment groups	
Enamel margin	Subgroup $1A^a$, $1B^a$, $3A^a$, $3B^a$> $2A^b$, $2B^b$, $4A^b$, $4B^b$
Dentin margin	Subgroup $1A^a$, $1B^b$, $3A^b$, $3B^b$> $2A^d$, $2B^e$, $4A^f$, $4B^e$
Comparison between Dentin and Enamel Microleakage	
Group 1A	Dentin>Enamel
Group 1B	Dentin>Enamel
Group 2A	Dentin>Enamel
Group 2B	NS
Group 3A	Dentin>Enamel
Group 3B	Dentin>Enamel
Group 4A	NS
Group 4B	NS
> indicate statistically significant difference in leakage scores (result of Kruskal-Wallis and/or Mann-Whitney test at significance level 0.05) Similar superscript/NS indicates no significant differences ($p>0.05$) Different superscript indicates significant differences ($p<0.05$)	