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ORIGINAL ARTICLE

Effect of Unfilled Resin Sealant Surface Coating on the Marginal Leakage of Two Cervical Restorations Viz Light Curing Nanoglass Ionomer and Nanoceramic Composite-An *In vitro* Stereomicroscopic Dye Penetration Study

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Abstract: The purpose of this study is to compare the marginal leakage of two aesthetic cervical restorative materials viz the newly introduced light cured nano glass ionomer cement and nano ceramic composites, and also to evaluate the effect of unfilled resin sealant coating on marginal leakage of these aesthetic restorations. Thirty freshly extracted human upper premolars were used for the study. Class V cavities were prepared on the buccal and lingual surface of each tooth, with occlusal margin in enamel and cervical margin in cementum. The teeth were randomly divided into two groups of fifteen teeth each. Cavities of group 1 were restored with nano composite and group 2 were restored with light curing nano glass ionomer cement, following manufacturer's instructions. After rinsing and drying one thin coat of unfilled resin sealant was applied only on to the surface of lingual restoration and were light polymerized for 15 seconds. The procedures for dye penetration using Methylene Blue were followed and examined under stereomicroscope for evaluation. The data collected were analyzed statistically using Mann-Whitney U test. Nanocomposite recorded less microleakage than nanoglass ionomer cement at occlusal and cervical margins. Results showed that cervical margin had significantly more microleakage than occlusal margin. Palatal surfaces, which were coated with resin sealant showed significantly less dye penetration in comparison with buccal surfaces in both groups. Though the coating of unfilled resin sealant did not completely eliminated microleakage, unfilled resin sealant was definitely effective in reducing microleakage of the esthetic restorations, especially on the gingival margin of the class V restorations.

Keywords: *Microleakage, Nanocomposite, Nano glassionomers and Unfilled resin sealant surface coating.*

Introduction

Restoration of cervical lesion presents a special challenge to the clinician, because of presence of two different types of tissues. The coronal margins of restorations are usually in enamel, while the cervical margins are in cementum and dentin. In comparison with bonding restoration to enamel, bonding to cervical dentin is less predictable due relatively low density and oblique orientation of dentinal tubules in cervical dentin [1]. The higher organic component, tubular structure, fluid pressure and lower surface energy of dentin make bonding to dentin more difficult than enamel [2]. Therefore, the main problem with restoring this kind of cavity is the leakage that occurs at the gingival margin located in dentin and cementum [3].

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A major advancement in the current practice of restorative dentistry is the restoration of class V cavities with tooth coloured adhesive material such as composite resin and glass ionomer cements [4]. One of the most important advances of the last few years in this field is the application of nanotechnology to resin composites and glass ionomer cement. Nanotechnology is known as the production and manipulation of materials and structures in the range of about 0.1 – 100 nanometers by various physical or chemical methods.

Due to reduced dimension of the particles and to a wide range of distribution, an increased filler load can be achieved with the consequence of reducing polymerization shrinkage [5] and increasing the mechanical properties such as tensile strength, compressive strength and resistance to fracture. On the other hand, the small size of filler particles improve the optical properties of resin composites because their diameter is a fraction of wavelength of visible light (0.4-0.8), resulting in the human's eye inability to detect the particle. So use of nanotechnology can offer high translucency, high polish and polish retention [6]. Furthermore, the wear rate is diminished and gloss resistance is better [7-8]. As consequence, manufacturers now recommend the use of nanocomposite for both anterior and posterior restorations.

In an attempt to overcome microleakage problem, using layer of low viscosity resin sealant over composite restoration has been investigated. This resin should penetrate into interfacial microgaps, especially in dentin cementum margins, thus promoting better marginal sealing. In addition material would fill the structural microdefects formed during the insertion technique and finishing and polishing procedures, thus increasing the wear resistance of the restoration [9-11]. All efforts till date have failed to completely eliminate the marginal contraction gap and prevent microleakage in class V restorations especially with gingival margins on dentin and cementum[12].

Objective of the study is to:

1. Compare the marginal leakage of light curing nano-glass ionomer cement restoration and nanoceramic composite restoration when used for cervical cavities.
2. Evaluate the marginal leakage of these materials when used with and without unfilled resin sealant surface coating.

Material and Methods

This study was carried out in the Department of Conservative Dentistry and Endodontics, and Department of Oral Pathology, Krishnadevraya college of dental sciences, Bangalore.

A total number of 30 sound extracted human maxillary premolars were used in the present study. The teeth were randomly divided in to two groups as per the following chart.

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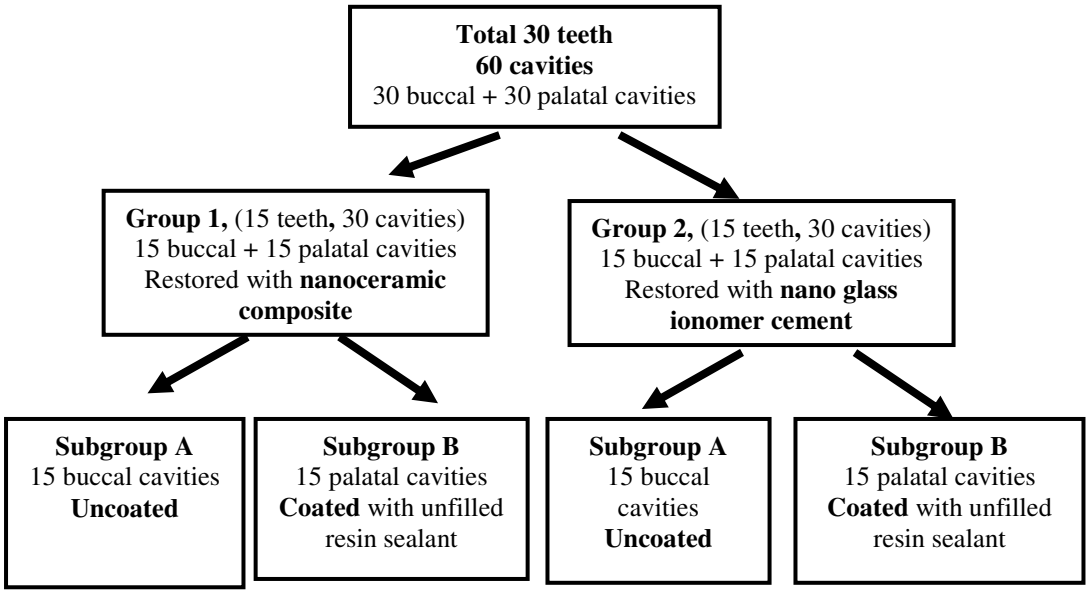

Group 1: *Cavity Preparation:* Standard class V cavities were prepared on the buccal and palatal surfaces of 15 teeth. The class V cavities were prepared to the dimensions of 3mm X 2mm X 1.5mm. The occlusal margins of the preparations were in enamel, and the cervical margins were in dentin and cementum. A 1mm bevel was placed on the occlusal enamel margin with a flame shaped diamond point.

Restoration: The cavities were restored with Nanocermic composite (Ceram X Duo, Dentsply) following manufacturer's instructions.

Group 2: *Cavity Preparation:* Class V cavities were prepared on 15 teeth similar to group 1 excluding bevel on enamel margin.

Restoration: The cavities were restored with Light-curing Nano-glass ionomer cement. (Ketac N 100,3M ESPE) following manufacturer's instructions. In each group, buccal cavities serve as subgroup A and palatal cavities serve as subgroup B. 15 cavities of subgroup A (i.e cavities on the buccal surfaces) were restored and finished, while cavities of subgroup B (i.e cavities on palatal surfaces) were restored and after finishing, one thin coat of unfilled resin sealant was applied to restoration/tooth surfaces and were light polymerized for 15 seconds. Teeth were stored in normal saline till the further period of study. All the specimens of both groups were then thermally stressed for 1000 cycles between 5°c and 55°c ± 2°c, with dwell time of 60 second in each bath and transfer time of 3 seconds. After thermocycling the teeth were dried. The root apices of specimens were sealed with utility wax and two coats of nail varnish applied to entire tooth surface, leaving 2 mm window around the restoration margin. The specimens were then placed in 1% methylene blue solution for 24 hours at room temperature. After removal from dye solution, the teeth were washed under running tap water and allowed to dry. The teeth were sectioned longitudinally through the restorations in a bucco-palatal plane with a diamond disc. The sections were kept ready for evaluation.

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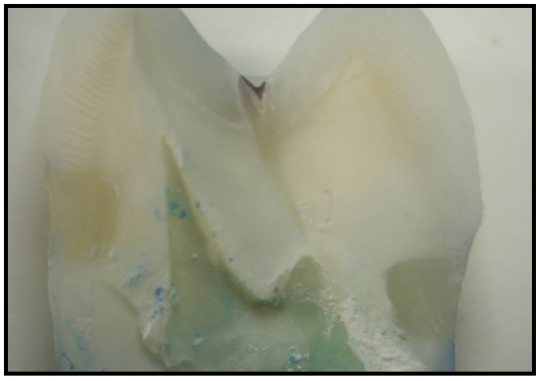
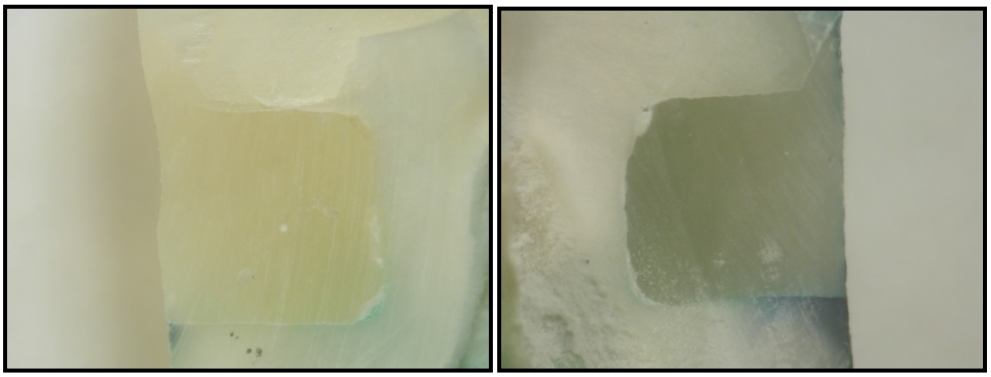
Figure-1: Specimen under stereomicroscope showing dye penetration



The sectioned specimens were observed under the stereomicroscope for marginal leakage and dye penetration. The following scoring criteria were used for the depth of dye penetration along the enamel (occlusal) and dentin-cementum (cervical) margins of the restorations. See figure no 1, 2, and 3.

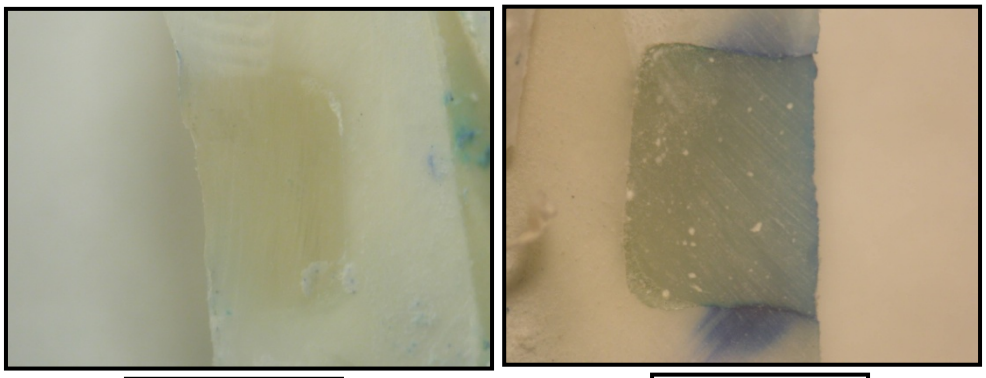
Figure-2: Dye penetration with Group 1 (Nanocomposite)



Palatal surface

Buccal surface

Figure-3: Dye penetration with Group 2 (Nano glass ionomer cement)



Palatal surface

Buccal surface

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Score 0→ No dye penetration.
Score 1→ Dye penetration up to one half the extension of the cavity wall.
Score 2→ Dye penetration greater than one half the extension of cavity wall, not including the axial surface.
Score 3→ Dye penetration greater than one half the extension of the cavity wall, including the axial surface.

Results

For each group score of dye penetration, mean and standard deviation were calculated. Statistical analysis for comparison of microleakage between the different groups was done by using Mann-Whitney U test.

Table no 1 and 2 depict the comparison of dye penetration between nanocomposite (group1) and nanoglass ionomer cement (group 2) along occlusal and cervical margins. On both coated and uncoated surfaces, nanoglass ionomer cement specimens showed significantly more leakage when compared to nanocomposite along occlusal and cervical margins.

Table-1: Comparison of dye penetration between materials along occlusal margin

Surfaces	Group	N	Mean Occlusal Margin score	Std. Deviation	Minimum score	Maximum score	Man Whitney U	"p' value
Buccal (uncoated)	I	15	0.87	0.834	0	3	47.500	0.005
	II	15	2.00	1.069	0	3		
Palatal (coated)	I	15	0.13	0.352	0	1	49.500	0.003
	II	15	0.87	0.743	0	2		
P< .05 = Significant								

Table-2: Comparison of dye penetration between materials along cervical margin

Surfaces	Group	N	Mean Cervical Margin score	Std. Deviation	Minimum	Maximum	Man Whitney U	"p' value
Buccal (uncoated)	I	15	1.73	.594	1	3	65.500	0.039
	II	15	2.33	.900	1	3		
Palatal (coated)	I	15	0.47	.516	0	1	53.500	0.007
	II	15	1.13	.640	0	2		
P< .05 = Significant								

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Table no 3 and 4 depict the comparison of dye penetration between buccal and palatal surface at occlusal and cervical margins. In both nanocomposite and nanoglass ionomer cement groups, buccal surfaces (uncoated) showed significantly more leakage when compared to palatal surfaces (coated) along occlusal and cervical margins.

Table-3: Comparison of dye penetration between buccal and palatal surfaces along occlusal margin

Group	Surfaces	N	Mean Occlusal Margin score	Std. Deviation	Minimum	Maximum	Man Whitney U	"p' value
Group I (Nano Composite)	Buccal (Uncoated)	15	0.87	0.834	0	3	50.500	0.003
	Palatal (Coated)	15	0.13	0.352	0	1		
Group II (nano GIC)	Buccal (Uncoated)	15	2.00	1.069	0	3	45.500	0.004
	Palatal (Coated)	15	0.87	0.743	0	2		
P< .05 = Significant.								

Table-4: Comparison of dye penetration between buccal and palatal surfaces along cervical margin

Group	Surfaces	N	Mean Cervical Margin score	Std. Deviation	Minimum	Maximum	Man Whitney U	"p' value
Group I (Nano Composite)	Buccal (Uncoated)	15	1.73	0.59	1	3	17.500	<0.001
	Palatal (Coated)	15	0.47	0.52	0	1		
Group II (nano GIC)	Buccal (Uncoated)	15	2.33	0.90	1	3	38.000	0.001
	Palatal (Coated)	15	1.13	0.64	0	2		
P< .05 = Significant.								

Discussion

In this study two newly introduced, light cured nano glass ionomer cement and nano ceramic composites, which are product of nanotechnology, are used as restorative material for cervical class V restoration. They supposed to have excellent aesthetics, superb polish, and high wear resistance according to manufacturers. Light cured nano glass ionomer cement has an added advantage of fluoride release. Active research is presently being conducted on the new light curing glass ionomer cements because of their unknown properties and handling protocols.

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Resin restoration materials rely on adhesive bonding to produce a seal between the restoration and tooth structure. Defective margins at the tooth-restoration interface can result from polymerization shrinkage following curing. Several methods have been suggested to reduce these destructive factors such as the use of rebonding agents, retention grooves, acid etch, enamel bevel, incremental placement of filling material, application of glass ionomers, flowable composite and self-cure composites under light-cure composites, indirect resin inlay, dentin bonding agents, suitable polishing techniques and slow polymerization speed. It has been shown that none of these methods could completely eliminate microleakage [13]. Attempt to seal the contraction gap by coating the polymerized composite resin and resin modified glass ionomer cement with bonding agent or resin sealants have been reported [4,9,12,14-17]. The rebonding technique has already been used in the past with glazes, but its benefits were limited due to inadequate adhesion to composites and accelerated wear, which decreased the longevity. Improvements in this technique could be found in the development of sealant of even lower viscosity to increase its penetration ability [4]. Penetration of the unfilled resin by capillary action would seal the marginal gaps, reducing the microleakage. Capillary action is directly related to the viscosity and wetability of the material [3]. Also, these materials must have coefficient of thermal expansion and contraction similar to tooth structure, and they must be compatible with the respective restorative material [9,18-19]. Use of these agents with a fluorescent additive showed resin penetration of 0.5 to 2.0 mm from cervical margin in to the cavity. In addition, this material would fill the structural microdefects formed during the insertion technique and finishing and polishing procedures, thus increasing the wear resistance of the restoration [10]. But some of the studies showed no effect of unfilled resin sealant on the marginal leakage of class v restoration [4,13]. In present study unfilled resin sealant is coated over finished restoration in an attempt to reduce the microleakage.

Results clearly indicate nanocomposites are superior to nano glass ionomer cements in preventing microleakage. This result is in agreement with study conducted by K Wenner and others [20]. The probable explanation for this result is: Bonding of resin modified glass ionomer and resin composite to the tooth structure is dependent on wetting of dentin due to the hydroxyethylmethacrylate (HEMA) content of the material. As HEMA content is more in the dentin bonding agent which is used with composite than in the resin modified glass ionomer, bonding of the composite to the tooth structure will be better leading to less microleakge compared to resin modified glass ionomer [17]. Study also confirms that unfilled resin sealant coated on finished restorations, unquestionably reduces microleakage of these class v restorations. But it could not prevent microleakage completely. The probable explanations for these results are:

1) Unfilled surface sealant, by the capillary action, will fill the structural microdefects and microfissures that are formed on the composite and resin modified glass ionomer cement. The ability to penetrate deeply in to the interfacial microgaps, provide marginal sealing[18]
2) Unfilled resin sealant coating protects the restorations from water contamination and desiccation in the initial setting stages.

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This result was is in agreement with other research [9-10,12,15-16,21). But result of study conducted by MCG Erhardt and others disagree with present result. This may be because of variation in the methods and procedure. They stored the restoration for six days under moisture at 37˚C prior to finishing and polishing and etching with 37% phosphoric acid was done before application of resin sealant. In our study finishing and polishing is done immediately and no etching is done prior to application of resin sealant.

The longevity of a rebonding agent in the contraction gap is unknown. Torstenson and others found that the rebonding agent penetrates in to the contraction gap of 0.5 to 2.0mm from gingival margins. Further investigation on the longevity of rebonding procedure is warranted.

Conclusion

Results of this study revealed that

1. In class V cavities nanocomposite restorations showed less microleakage than nano glass ionomer restorations.
2. Invariably, in class V cavities occlusal margins showed less microleakage than gingival margins.
3. Unfilled resin sealant used in the study reduced micoleakage of both, nanocomposite and nano glass ionomer class V restorations.

Within the limitations of this study, it can be concluded that, though the coating of unfilled resin sealant did not completely eliminated microleakage, unfilled resin sealant definitely effective in reducing microleakage of the esthetic restorations namely nanocomposite and nano glassionomers, especially on the gingival margin of the class V restorations. However additional in vivo studies are required to further substantiate the findings of this study.

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