Research Article

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Evaluation of the Sealing Ability of Glass Ionomer Cements used for Sandwich Restoration using Different Etching Patterns

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ABSTRACT

Aim: The purpose of this study was to evaluate the sealing ability of GIC used for sandwich restorations and to assess the effect of acid etching of GIC on micro leakage at GIC- composite interface.

Method: Cavities were prepared on the mesial surface of 30 permanent human premolars, which were randomly divided into three groups (n=10). Group I – control group GIC was applied onto the axial and cervical cavity walls and allowed to set, it was followed by the bonding agent and composite. Group II (Total Etch group) – same as Group I except Acid etching was done on the GIC surface before the bonding agent and composite. Group III (Self – Etch group) – same as Group I except for G-Bond was applied before composite. Specimens were soaked in methylene blue dye solution at room temperature for 24 hours, rinsed under running tap water for one hour, bisected longitudinally and dye penetration was measured following the ISO/TS 11405-2003 standard.

Result: No significant difference in microleakage was seen between Group II and Group III whereas significant microleakage was seen in Group I compared to other two groups.

Keywords: Composite, GIC, Sandwich technique.

INTRODUCTION

The glass – ionomer cement (GIC) was discovered by smith in the late 1960's, by replacing the phosphoric acid by polyacrylic acid in zinc phosphate cements. Initially it was thought to unite properties of the silica glass powder, such as high strength, hardness and the capacity to release fluoride, with the biocompatibility and adhesion ability of the polyacrylic acid liquid. [1] The most interesting property of this dental material turned out to be the anticariogenic property resulting from fluoride release. The other properties of GIC like the adhesion mechanism to tooth structure, thermal compatibility with tooth enamel, biocompatibility and low cytotoxicity rendered GIC to be an interesting clinical option for restorative treatments. [2]

A composite restoration has to form a micromechanical bond with the tooth structure to attend the required tooth- material bond. Thus in other to achieve bonding of composite to tooth structure one of the following adhesion strategy has to be considered: the etch and rinse approach, self-etch approach and glass-ionomer approach. [3] Usually, 30–40% phosphoric acid etchant is used in Etch and rinse technique, while non-rinse acidic monomers is used in the self-etch approach that simultaneously condition and prime dentin and enamel. There are two types of self-etch systems first is two-step and other is one-step (all-in-one)

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adhesives. In One-step self-etch systems, a single solution contains all the components (etchant, primer and bonding resin) of an adhesive system and combines all the three bonding steps into a single application. Thus clinically self-etch systems not only simplifies the bonding process but also eliminates some of the technique sensitivity associated with the use of etch and rinse systems by few steps eliminaton.[4] Furthermore, as the moisture level of dentin is not a critical factor to take in account with these adhesives, the issue of wet bonding is no more an issue of concern by use of these materials. Moreover, the risk of incomplete resin infiltration is eliminated by simultaneous infiltration of the exposed collagen fibril scaffold with the resin up till the same depth of demineralization.[5]

As a result, their popularity has increased subsequently. One of the advantages of using single-step (self- etch, one-component adhesives) is it can prevent discrepancies occurring between the depth of etching and resin monomer penetration. This is because the self-etch one-component adhesive system forms a continuous layer by simultaneous demineralization with acidic monomers, followed by resin monomer penetration into the dentin substrate.[3]

As self-etch adhesives use acidic monomers instead of the traditional phosphoric acid to condition tooth structure, they do not produce the same degree of porosity in enamel surfaces as that attained with phosphoric acid etching.[6] There is a significant difference in enamel roughness with the self-etch adhesive systems when compared to the traditional phosphoric acid conditioning system.[7] McLean *et al.*[8]stated that for bonding composite resin to GIC, set GIC surface has to be etched with phosphoric acid before the application of resin bond. The clinical technique explained by Mount[9] suggests the etching of the initially set GIC for 15 seconds prior to placing a layer of resin bond to develop an expected mechanical bond between the two materials. Bond strengths will improve considerably if the GIC is etched after 24 hours of maturation.[10]

The purpose of this study was to evaluate the sealing ability of Glass Ionomer cements used for sandwich restoration by using different etching methods i.e. etch and rinse technique and self- etch technique all in one adhesive by the use of optical microscope.

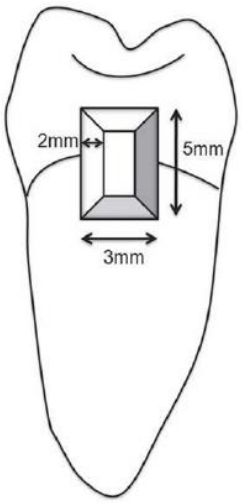

Fig 1a: Schematic image of the window-like cavity prepared on proximal tooth surface and its dimensions.

Fig 1b: Longitudinally bisected tooth specimen.

MATERIALS AND METHOD

Non – carious 30 extracted human permanent premolars with fully developed roots were selected for this Study. The teeth surface were made free of calculus, soft tissue and other debris if any, and stored in saline at room temperature. A small

window-like cavity was prepared on the proximal surface of each tooth using Mani's diamond bur SF - 21 and carbide bur FG58 from SS White at high Speed, as shown in Figure 1 a. The materials included were conventional GIC (GC,Fuji), adhesive system - G-bond (GC) and a Composite resin (Restofill). All materials were handled at room Temperature (23ºC) following the manufacturers' instructions. The 30 cavities prepared tooth were randomly assigned to 3 groups (n=10) and restored according to the sandwich technique.[11] The study groups were as follows: *Group I* - GIC was applied onto the axial and cervical Cavity walls and was allowed to set for 5 min followed by the bonding agent application and curing it with LED light for 10 s. The restoration was completed with a layer of Composite which was light cured for 40 s; *Group II* - same procedure as described for *Group I*, except for acid etching of the GIC surface and the cavity margins with 35% phosphoric acid for 15 s, which was washed with air-water spray after 30 s and blotted dry with an absorbent sponge; *Group III* - same procedure as described for Group II, but G-bond was used instead of etching and bonding. All restorations were polished with Sof-Lex discs (Shofu). Teeth samples were then coated with 3 layers of nail varnish (Lakme), except for the window area which was restored and 1 mm around it. The samples were then soaked in 1% methylene blue dye solution at 24ºC for 24 h, then rinsed under running water for 1 h.

The teeth were bisected longitudinally (Figure -1 b) to separate the buccal and palatal surfaces from each other using the straight hand piece and the diamond disc. The specimens were then examined under an optical microscope for marginal sealing and leakage. Representative images were recorded from all the samples and maximum degree of dye penetration was recorded according to the following scores (ISO/TS 11405-2003)[12] given by Alvaro DELLA BONA[1]: 0 = no dye penetration (Figure 2 a); 1 = dye penetration into the enamel portion of the cavity wall (Figure 2 b); 2 = dye penetration into the dentin portion of the cavity wall but not including the pulpal floor of the cavity(Figure 2 c); 3 = dye penetration including the pulpal floor of the cavity (Figure 2 d). Results were statistically analyzed by ANOVA and Mann-Whitney U test.

Fig 2a: Score 0.

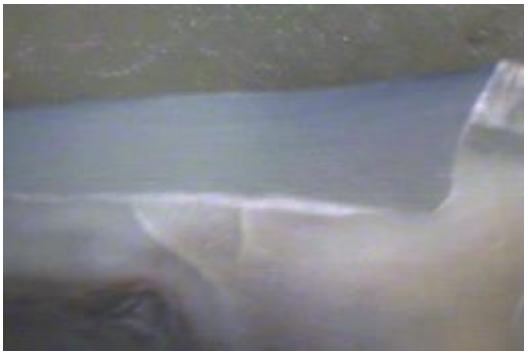

Fig 2b: Score 1.

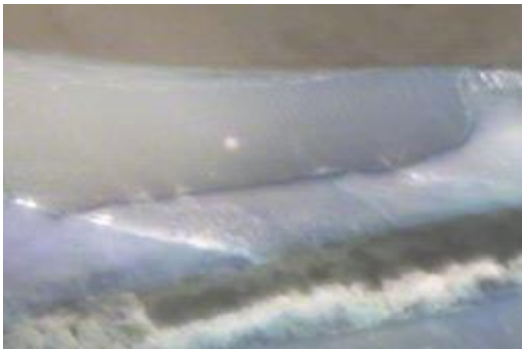

Fig 2c: Score 2.

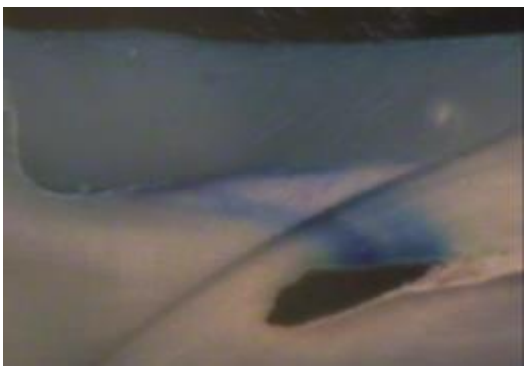

Fig 2d: Score 3.

DISCUSSION

Accounting to the availability of many products in the market and due to the increased patients demand for aesthetic restorations, it is of utmost importance to evaluate the quality and reliability of the new adhesive systems in reducing the micro leakage of composite restorations through laboratory investigation. The window preparation was done for all the samples with an intention of maintaining a standardised shape and size of the cavities prepared at the cemento-enamel junction with a cylindrical diamond bur. It was made sure that the margins of the cavities are butt jointed, half in the enamel and half in the root dentin.[13]

Table 1: Distribution of Microleakage Score.

	Microleakage Score						
Study Groups	Score 0 n (%)	Score 1 n (%)	Score 2 n (%)	Score 3 n (%)	Score 4 n (%)	Mean Score	SD Score
Group 1 (n=10)	0	0	0	7 (70.0)	3 (30.0)	3.30	0.48
Group 2 (n=10)	4 (40.0)	5 (50.0)	0	1(10.0)	0	0.80	0.92
Group 3 (n=10)	5 (50.0)	5 (50.0)	0	0	0	0.50	0.53

Table 2: P–values by Mann–Whitney U test with the necessary corrections for multiple group comparisons. P–value < 0.05 is considered to be statistically significant.

Comparison of Groups	P-values (Significance)
Group 1 v/s Group 2	0.001 (HighlySignificant)
Group 1 v/s Group 3	0.001(Highly significant)
Group 2 v/s Group 3	0.579 (Non Significant)

The polymerization shrinkage developed during the conversion of the monomer molecules into a polymer network is an undesirable resin composite phenomenon which can be considered one of the major factor responsible for the lack of adaptation of the restoration to the cavity walls, leading to increase in the susceptibility to caries especially in deep regions of the proximal box of Class II cavities.[14] The use of GIC as an under filling material in conventional sandwich restoration accounts to a considerable reduction in the bulk of resin composite material being used. Thus, leading to the decrease in the amount of polymerization shrinkage of the composite resin and may thus improve the marginal adaptation of the composite material with the tooth surface. It is biocompatible to the dentinal surface and thus, acts as a substitute for dentin. Another interesting advantage of the sandwich technique is the fluoride-release property of GICs, which is considered to have some inhibitory effect on caries formation and progression around the restoration.[11] The GIC is till date considered to be the only dental material with self-adherence proterty[15] and it has been previously shown that GIC and composite resin can adhere effectively to each other [8,14,16,17] regardless of the limitations concerning this system.[18]The bond strength between GIC and Composite are influenced maily by four factors: 1) the tensile strength of GIC, which is mostly dependent on the powder/liquid ratio; 2) the viscosity of the bonding agent and its ability to wet the GIC's surface; 3) the volumetric change in the composite resin during polymerization and; 4) the difficulties in packing and adaptation of the composite resin to the GIC without incorporation of voids.[18] It has been suggested that the acid etching of GIC surface would lead to a cleaned mildly roughened surface with high surface energy.[13] Thus, by performing acid etching it is assumed that it would fulfil the requirements to a closer contact and lead to a greater interlocked interface between GIC and composite resin.[8,14]

For long, leakage has been recognized as a major problem in restorative dentistry.[16] Thus micro leakage studies are considered to be useful in estimating the resistance of tooth-restoration interface to the passage of bacteria, fluids, chemical substances, molecules and ions.[19] Absence of a strong seal at tooth restoration margins results into tooth discoloration, adverse pulp response, postoperative sensitivity, and recurrent caries.[20] Thus, few *in vitro* studies conducted to predict the clinical marginal sealing ability of several restorative techniques found lesser micro leakage when GIC was used as a filling material beneath the composite resin.[21] Despite these fabulous results, the clinical performance of sandwich restorations does not seem to be very effective and some failures have been reported, mainly concerning the GIC portion.[22] Some researchers have stated that this

laminate restoration is an interesting alternative to amalgam, especially in high-caries risk patients.[23]

Consistent bond strength to dentin is guaranteed by the 4-META monomer on the other hand Phosphoric Acid Ester Monomer ensures a tight bond to enamel. The remarkably thin, bubble free adhesive layer coats all bonding surfaces completely, even in extremely shallow cavities which is not visible after polymerization. Oral durability is guaranteed because new G-BOND is HEMA free thus the water uptake, discoloration and possible loss of retention are a thing of the past.

Adhesive luting agents present physical properties of bonding between indirect restorations and the tooth structure thus playing a vital role in the sealing of the margins and preventing marginal leakage. However, most of the dental cements available cannot assure continual impermeability.[24] A number of experimental methods have been used to evaluate the microleakage in case of sandwich technique. Out of which dye penetration is generally recognized as a good indicator of bacterial invasion. Therefore, bacterial invasion to tooth surface may occur when dye penetration depth is greater than the thickness of the material. In such a circumstance, the restorative material fails to provide protection against bacterial infection.

Assessing micro leakage with methylene blue dye penetration is one of the most common methods used by the authors for their experimental studies. This dye has high solubility in water, it can move by simple diffusion and it is also not absorbed by the hydroxyapatite crystals of dentin. Recent studies evaluating micro leakage used various dyes to check for penetrations, e.g. Zaia *et al.* used India ink, Tewari *et al.* And Zmener *et al.* used 2% methylene blue, Jenkins used India ink and Suehara *et al.* also used dye penetration in evaluating microleakage.[22]

RESULT

The sample size, dye penetration scores, dye penetration score means and statistical grouping are summarized in Table2. No significant differences were found between Groups II and III and between Groups I and II ($p>0.05$) regarding dye penetration means. When both surface treatments (Etching and Self - Etching) were considered, no statistically significant differences were found ($p>0.05$). However, significant differences were observed between the not etched and etched surfaces showing a significantly greater dye penetration score mean. This finding was statistically insignificant ($p>0.05$). Whenever micro leakage occurred, the maximum degree of dye penetration was always evident within the slice obtained below the CEJ.

CONCLUSION

Within the limitations of this study, the results suggest that the scores obtained from the optical microscope when analyzed statistically showed that micro leakage was significantly higher in group I that was the control group when compared to group II being the etchant group and group III – self-etch group.No statistically significant difference was seen between groups 2 (Etchant Group) and group 3 (Self-Etching Group) but Group 3 (Self-Etching Group) gave better results than the other two groups.

Clinical Recommendation

Etching of set GIC before placement of the composite restoration is highly recommended. Difference between the self etched and surface etching with phosphoric acid did not show significant difference, though use of self – etchant may be preferable due to the single step etching and bonding as there will be less chances of contamination due to oral fluids and it will be more convenient clinically.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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