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COMPARATIVE EVALUATION OF SHEAR BOND STRENGTH BETWEEN RESIN MODIFIED GLASS IONOMER CEMENT AND COMPOSITE RESIN USING THREE DIFFERENT ADHESIVE SYSTEMS AND TWO DIFFERENT CURINGTECHNIQUES- AN IN VITRO STUDY

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ABSTRACT

Introduction: Self-etch approach either two-or one-step adhesives are more user-friendly due to the time-saving and simplified procedure. The application of self-etch adhesives on GI or RMGI improve the bond strength to composite in comparison with total etch adhesives. Not many studies conducted to test whether pre curing or co-curing technique is better for conservative restorations. This study was done to evaluate shear bond strength of Resin modified glass ionomer cement to composite resin, using different adhesive systems with different curing techniques. **Material and Methods:** A total of 60 acrylic moulds (20mm × 20mm × 25mm) were prepared and in that hole was created (6mm × 6mm × 2mm). Resin modified glass ionomer cement was filled in 2mm height of acrylic moulds and kept uncured. The surface of Resin modified glass ionomer cements were softened by hand instrument and divided into two groups of 30 – Group A (Pre curing) and Group B (Co-curing) technique in each were sub divided into three subgroups of 10 according to adhesive systems (total –etch, two-step self-etch, one-step self- etch) were applied. **Results:** Group A2 (Two step self) had statistical significantly higher shear bond strength ($p<0.05$) as compared to subgroup A1 (Total Etch) and subgroup A3 (One step self) in both Group A (Pre curing) and Group B (Co-curing). Shear bond strength was statistical significantly higher in Co-curing groups as compared to Pre-curing groups in self-etch adhesive systems. **Conclusion:** This study concluded that shear bond strength between resin modified glass ionomer and composite resin was increased with the application of co-curing technique andself-etch adhesive system.

KEYWORDS: Adhesive system, Curing technique, resin modified Glass ionomer cement, shear bond strength.

INTRODUCTION

The improved performance of resin composites and the increasing demand for esthetic perfection has encouraged more clinicians to select resin composites for posterior restorations as a possible alternative to amalgam. However, the clinician should be aware of certain disadvantages when using a resin composite, such as polymerization shrinkage, associated microleakage, pulpal irritation and lack of anticariogenicity.[1]

The use of bilayered restorations is one of the recommended composite restorative techniques used in dentistry, and they are known by various names such as double laminate technique or sandwich restorations.[2] The concept of the lamination technique is to use two different restorative materials to form one restoration. The rationale behind the technique is to make themost of the physical and esthetic properties of each material as it combines the dentin-adhesion and fluoride release of glass ionomer as well as the aesthetics and polishability of resin.[3]

The first laminated restorations used conventional auto-cure GIC that develops mechanical interlock between it and composite resin. McLean *et al*.[4] described bonding composite resin to GIC by etching the set GIC with phosphoric acid prior to applying resin bond. The clinical technique described by Mount[5] suggests etching the initially set GIC for 15 s prior to placing a layer of resin bond to develop a mechanical bond between the two materials. However, failure occurred due to sensitivity to moisture and the progressive loss of the GIC.[6]

The bond strength between conventional GICs and composites is limited by the low cohesive strength of glass-ionomers due to the lack of chemical bonding. This could be attributed to the difference in the setting

reactions between dental composites and conventional GICs.[7] Bond strengths improve if the GIC is etched after 24 h of maturation.[8,9] However, this procedure requires an additional clinical visit to complete a restoration.

Some studies suggest the application of resin modified glass ionomer cement instead of glass ionomer in sandwich technique due to better mechanical properties, more resistant to moisture and higher bond strength to composite, resin modified glass ionomer cement can bond chemically to composite through co-polymerization of un-reacted monomer (hydroxyethyl methacrylate [HEMA]) in air-inhibited layer of superficial surface of cured RMGI with adhesive systems or composite resins. Furthermore, it may provide covalent chemical bond between adhesive resin systems and residual monomer in polyacid chains within the cured resin modified glass ionomer cement.[10]

The marginal adaptation is also affected by bonding strategies. There are two clinical approaches to achieve dentine bonding: "etch-and-rinse" and "self-etch" techniques. The etch- and-rinse bonding system involves total etching of enamel and dentine, followed by application of primer/bonding agent. This may incorporate a discrepancy in the penetration of resin monomers to the full depth of demineralized dentine. To overcome this problem, self-etch adhesives were introduced. The self-etch systems eliminate the separate etching step, as the acidic monomers simultaneously etch and prime the smear layer coated dentine. The self-etch systems have claimed to be less technique sensitive and clinically reliable.[11]

The self-etch approach either two-or one-step adhesives are more user-friendly due to the time- saving and simplified procedure. The application of self-etch adhesives on GI or RMGI improve the bond strength to composite in comparison with total etch adhesives. Self-etching systems combine the functions of primer and adhesive components and do not need an "etch and-rinse" phase, which not only decreases clinical application time, but also significantly reduces technique sensitivity. Another important advantage is that the infiltration of resin occurs simultaneously with the self-etching process, by which the risk of discrepancy between both processes is low or non-existent. The self-etch effect should be ascribed to non-rinsing, polymerizable monomers to which one or more carboxylic or phosphate acid groups are grafted. Studies have proven that self-etch systems produce bond-strength values similar to total-etch systems to both dentin and enamel.[10]

In co-curing technique, two different light-cured materials were coincidently polymerized. Knight el al. in their study suggested the application of co-curing technique for RMGI and composite can decrease the internal stress incomposite restorations and also reduce the clinical steps. Furthermore, simultaneous curing of RMGI with composite increases the bond strength between GI and composite.[10] Co-curing may be defined as the simultaneous photo polymerization of two different light activated restorative materials. The procedure was initially used to bond composite resin and RMGIC and has been developed subsequently to incorporate a RMGIC as an intermediary bond between GIC and composite resin. The sequential layering of GIC, RMGIC and composite resin prior to photo polymerization, and before the initial set of the GIC, enables an efficient single visit placement of a restoration although there is a lack of comparison of bond strengths between the GIC "etch and bond" technique and co-curing.[12] This study was done to evaluate shear bond strength of Resin modified glass ionomer cement to composite resin, using different adhesive systems with different curing techniques. The null hypothesis was there exist no statistical significant difference in relation to shear bond strength of Resin modified glass ionomer cement to composite resin, using different adhesive systems with different curing techniques.

MATERIALS AND METHODS

A total of 60 acrylic moulds (20mm × 20mm × 25mm) were prepared and in that hole was created (6mm × 6mm × 2mm). Resin modified glass ionomer cement was filled in 2mm height of acrylic moulds and kept uncured. The surface of Resin modified glass ionomer cements were softened by hand instrument and divided into two groups of 30. Two different curing techniques were applied: In pre-curing technique (Group A), the prepared Resin modified glass ionomer cement were stored in a dark environment for 1min and then light cured at 800mW/cm^2 for 20. In Co-Curing technique (Group B), curing of prepared resin modified glass ionomer cement along with adhesive system was done. The procedure is similar to the former group, after 1 min of storage in a dark environment; however, uncured RMGI samples are coincidently cured with adhesive systems applied on it. The specimens were randomly divided into three subgroups of 10 according to adhesive systems (total – etch, two-step self-etch, one-step self-etch) were applied.

Transparent plastic ring was placed on resin modified glass ionomer cement. Then, 2mm flowable composite resin was placed in a plastic ring and was cured for 40s. All procedures were performed by a single operator. Samples were stored in 100% humidity for 48 hr and then shear bond strength was measured by universal testing machine at cross head speed of 1 mm/min. Load was applied at the interface of composite resin and resin modified glass ionomer cement.

Statistical Analysis

Data received from lab were entered in Microsoft Excel 2019. Statistical Product and Service Solution (SPSS) version 21 for Windows (Armonk, NY:IBM corp) software was used to analyse the data Statistical analysis

was done by using tools of descriptive statistics such as Mean, and SD for representing quantitative data. Probability p<0.05, considered as significant as alpha error set at 5% with confidence interval of 95% set in the study. Power of the study was set at 80% with beta error set at 20%. Intragroup comparison of shear bond strength among three types of adhesives groups for each curing technique group will be done using One way Anova 'F' test followed by Tukey's post hoc test for pairwise comparison. Intergroup comparison between both curing technique groups will be done using unpaired t test.

RESULTS

On comparison of Shear bond Strength (Mpa) among three adhesive groups (A1 A2 and A3) in Group A (Precuring Technique) using One way Anova F test, there was found to be statistical significant difference (p<0.05) among the three adhesive groups. Group A2 (Two step self) had statistical significantly higher shear bond strength (p<0.05) as compared to subgroup A1 (Total Etch) and subgroup A3 (One step self). Group A3 (one step) had higher shear bond strength as compared to Group A1 (Total Etch) but the difference was not found to be of statistical significance. (Table 1)

On comparison of Shear bond Strength (Mpa) among three adhesive groups (B1 B2 and B3) in Group B (Co-curing Technique) using One way Anova F test, there was found to be statistical significant difference (p<0.05) among the three adhesive groups. Group B2 (Two step self) had statistical significantly higher shear bond strength (p<0.05) as compared to subgroup B1 (Total Etch) and subgroup B3 (One step self). Group B3 (one step) had higher shear bond strength as compared to Group B1 (Total Etch) and the difference was also found to be of statistical significance(p<0.05).(Table 1)

On comparison of shear bond strength between two main groups i.e precuring vs Co-curing techniques using unpaired t test, it was observed that for subgroup A1vs B1 (Total etch), shear bond strength was statistical significantly higher in Precuring groups as compared to Co-curing groups. But on comparison of shear bond strength between two main groups i.e precuring vs Co-curing techniques using unpaired t test, it was observed that for subgroup A2 vs B2 (Two step etch) and A3 vs B3 (One step etch), shear bond strength was statistical significantly higher in Co-curing groups as compared to Pre-curing groups.(Table 2)

Table 1: Pair wise Comparisons of Shear bond Strength among three groups(A1 A2 and A3) in Group A and Group B by Tukey's post hoc Test.

Multiple Comparisons						
Dependent Variable: Shear Bond Strength (Mpa)Tukey HSD						
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig. p value	95% ConfidenceInterval	
					Lower Bound	Upper Bound
Group A1	Group A2	-1.13500*	.17891	<0.001*	-1.5786	-1.13500*
Group A1	Group A3	-.37700	.17891	.107	-.8206	-.37700
Group A2	Group A3	.75800*	.17891	.001*	.3144	1.2016
Group B1	Group B2	-5.59600*	.19466	<0.001*	-6.0786	-5.59600*
Group B1	Group B3	-4.87200*	.19466	<0.001*	-5.3546	-4.87200*
Group B2	Group B3	.72400*	.19466	.003*	.2414	.72400*

*. The mean difference is significant at the 0.05 level.

Table 2: Comparative Statistics for Shear bond Strength among Six groups.

Group	Subgroups	N	Mean	Std. Deviation	F	Sig. p value
	A1 :Total					
	Etch Pre-	10	17.0320	.37623		
	Curing					
Group A PRECURING TECHNIQUE	**A2 : TwoStep Self Etch Pre-Curing**	10	18.1670	.26650	20.879	<0.001*
	A3 : One					
	Step Self Etch Pre-	10	17.4090	.51725		
	Curing					
	B1 :Total					

	Etch Co-	10	14.8950	.44764		
	Curing					
	B2 : Two					
Group B CO-CURING	**Step SelfEtch Co-**	10	20.4910	.46059	488.903	<0.001*
TECHNIQUE	**Curing**					
	B3 : One					
	Step Self Etch Co-	10	19.7670	.39477		
	Curing					

*. The mean difference is significant at the 0.05 level.

DISCUSSION

Adhesive dentistry has gained steady importance in restorative dentistry during past four decades with the chief goal to achieve an adequately strong bonding of the restorative resin to the tooth structure for optimum retention, minimal microleakage, better colour stability and clinical longevity of the restoration. GIC adhesion mechanism to tooth structure, thermal compatibility with tooth enamel, biocompatibility and low cytotoxicity render to GIC an interesting clinical option for restorative treatments. Thus, the so-called sandwich restoration or "composite-laminated GIC" technique has been used by clinicians.

In the present study, select bond TE(5th generation bonding agent) showed the lowest bond strength(14.9 Mpa) values as compared to clearfill liner bond(20.49Mpa) and wonder bond SE (19.77Mpa) with the co-curing technique used. The reason for low strength may be due to important factors Acid etching and rinsing that will possibly have significant effect on bond strength. A study by Bracket and Huget demonstrated that the application of acid etching can improve the bond strength between RMGI and composite. In contrast, Kerby and Knobloch demonstrated this procedure can decrease the bond strength through a partial elimination of HEMA and un-reacted methacrylate groups in air-inhibited layer. However, some studies showed the inhibition or decreasing of penetration of acid into RMGI due to the high resin content and formation of polymeric matrix. Therefore, they concluded that acid etching has no significant effect on bond strength of RMGI to composite.[13]

Another reason for the low bond strength is an acidic nature of adhesive agents makes the superficial surface of the GIC dissolve, thereby improving the bonding of GIC to the composite resin. In addition to a low pH, the Self-Etch adhesive used in the present study has less viscosity compared to the Total-etch adhesive. A study by GJ Mount, 1989, has shown that a bonding agent having less viscosity shows a lesser contact angle to the surface, and results in better wettability, which helps in promoting a better bond between RMGIC and the resin composite.[5]

In the present study RMGIC was used over the conventional GIC under composite resin restoration because RMGIC sets by an acid-base reaction and exhibits a command set when activated by light or chemical agents via the methacrylate group. RMGIC has also demonstrated a better bonding to composite resin than the conventional GIC. This is due to a similar chemistry between RMGIC and the composite resin, which allows the strong bonding of RMGIC to composite resin. Both RMGIC and the resin composite are cured by a free radical initiator system, which provides a potential for the chemical bonding between these two materials.[12] In this study, increased bond strength was evaluated between composite and resin modified glass ionomer cement using self-etch adhesive system. This finding is consistent withthe results obtained by Arora et al.[13] and Kandaswamy et al.[14]

Higher shear bond strength values were found when using co-curing technique in consistent with the findings obtained by knight et al. Co-curing RMGIC bond and composite resin onto GIC prior to initial set also produces chemical bond strengths beyond the cohesive strength of GIC. Apart from further reducing the time required to place a restoration, clinical experience has shown that the pneumatic pressure applied with a gloved thumb (prior to co-curing) creates a piston effect with the composite resin forcing the lower viscosity GIC into any voids remaining during placement of the GIC at the cavomargins. The exothermic polymerization of composite resin heats up the surface of the pre-set GIC and may reduce the setting time of the GIC. Knight et al. in their study suggested the application of co-curing technique for RMGI and composite can decrease the internal stress in composite restorations and also reduce the clinical steps.[12] The authors' assumption was that simultaneous curing of RMGI and adhesive systems may increase penetration of adhesive systems into RMGI before curing and so the bond strength will improve.

McLean et al. pointed out that it is possible to etch the surface of a conventional GIC and develop a mechanical union between the cement and the bonding agent/composite resin similar to that developed between etched enamel and the composite resin.[4] However, sensitivity of the GIC to moisture and its progressive loss following acid etching often leads to its failure as moisture contamination during the initial setting of GIC can cause dissolution of the weak calcium- polyacrylate chains, and degrade their physical properties. Moisture contamination during the rinsing procedure can be prevented by waiting for about seven minutes for the initial setting of the GIC to be complete before starting the etch and rinse procedure. Since this procedure

requires a waiting period, this technique is not popular among restorative dentists.[15]

The recent development of adhesive systems such as self-etch primers might overcome this disadvantage, as they do not require etch and rinse procedure. Self etching systems are less technique sensitive and require less application time. They do not require etch and rinse phaseand combine the functions of primer and adhesive making them more convenient in manipulation. In these systems, there is simultaneous infiltration of the resin with the self- etching process. Studies have proven that self-etch systems produce bond strength similar to total-etch systems to both dentin and enamel. The other advantage of these systems is their feasibility to be employed over unset GIC, as there is no need to rinse the GIC prior to application of the bonding agent, thus preventing moisture contamination or desiccation of the underlying GIC and saving precious chairside clinical time.[16] So this study showed increased shear bond strength between composite and resin modified glass ionomer cement using self- etch adhesive system.[1]

This technique was developed by McLean and others[4] in 1985; they used the dentin adhesive properties of glass ionomer cements (GICs) to seal cavities and reduce microleakage. This technique benefits from the advantages of GIC fluoride release combined with esthetic resin material to enhance clinical serviceability. However, the bond between conventional GICs andresin composite is limited due to a lack of chemical bonding between the two materials and also the low cohesive strength of glass ionomers. This could be attributed to the difference in setting reactions between dental composites and conventional GICs.[1]

Tyas et al. have shown the predictable nature of composite resin bonded to tooth structure using a RMGIC bonding system. The placement of the RMGIC bond over the surface of the GIC and cavosurfaces within a tooth facilitates placement of a layer of composite resin that can be co- cured with RMGIC bond to both the tooth and the GIC. Resin modified glass ionomer cement(RMGIC) bonding agents have been shown to provide predictable long-term bonds between tooth structure and composite resin.[12] So in this study, resin modified glass ionomer cement was used. From the results of the present study, it was observed that shear bond strength between resin modified GIC and composite was increased when using two step self-etch adhesive system as compared to self-etch one step and total etch adhesive system with co-curing technique used.

CONCLUSION

This study concluded that shear bond strength between resin modified glass ionomer and composite resin was increased with the application of co-curing technique and self-etch adhesive system. Hence, co-curing technique can be favoured over precuring technique and two step self-etch adhesive can be preferred over total etch adhesive and one step self etch technique.

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