Original Research Paper
Volume - 14 | Issue - 01 | January - 2024 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar
Dentistry

INFLUENCE OF SURFACE PRETREATMENT OF RESIN MODIFIED GIC ON MICROLEKAGE BETWEEN RMGIC AND RESIN COMPOSITE- AN INVITRO STUDY

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ABSTRACT

Objective: The present study was planned to compare the effect of different surface pretreatments of RMGIC on microleakage when used in sandwich technique. **Material and Methodolgy:** 35 RMGIC blocks were divided into 5 groups based on the method of surface treatment Group 1: (control group): No surface preparation,Group 2: Acid etching with 37% phosphoric acid, Group 3: 30-µm Al_2O_3 particles Group 4: Rough diamond bur ,Group 5: Er, Cr: YSGG laser.Two samples from each group were randomly examined under surface profilometer. Composite resin Restoration was done and cured. Samples were then examined under stereomicroscope for marginal sealing and leakage using dye penetration method. **Results:** The mean Ra and Rq values was significantly highest in Group 5 at $p<0.00$ indicating an increase in the surface roughness in the RMGIC after laser treatment while there was not any significant surface topographic alteration in the other groups. **Conclusion:** Microleakage was significantly less in the laser-etched group leading to increased bond strength and homogenous restorations

KEYWORDS : Lasers; Microleakage; Resin composite; RMGIC; Sandwich restorations.

INTRODUCTION:

The main goal of dentistry is to have materials that, when employed for cavity restoration, have a minimally harmful effect on pulp and an appropriate seal at the microscopic level [1]. A good seal, less micro leakage, a solid bond, and a successful restoration are all ensured by properly preparing the dentine surface before placing the restoration[2]. The introduction of adhesive restorative systems and the development of acid etching have completely changed the way cavities are prepared, allowing for a more aesthetic procedure and higher preservation of healthy dental structure. The smear layer created during dental tissue preparation needs to be either eliminated or altered in order to establish adhesion between dental tissues and restorative materials. Dentin is demineralized to accomplish this, either through the use of a self-etching adhesive system or a separate acid etching phase. The tooth substrate that has been created using standard methods will be the target of the developed adhesive systems. Nevertheless, more recent times have seen a rise in the use of newer techniques for cavity preparation like lasers and abrasion techniques [3].

GIC is an intriguing clinical option for restorative therapies due to its attachment mechanism to dental structure, thermal compatibility with tooth enamel, biocompatibility, and minimal cytotoxicity . Clinicians have chosen the so-called sandwich restoration or "composite-laminated GIC" approach. By employing a resin composite laminate, this improves the aesthetic and mechanical characteristics while preserving the fluoride release mechanism and chemical link to tooth structure given by GIC[4].

The requirement for GIC surface treatment prior to the insertion of composite resin in sandwich restorations is still up for debate.Despite the fact that pre-treatment of enamel and dentin before the application of bonding methods and restorative materials is well established in the literature. According to McLean et al., it is conceivable to etch a typical GIC's surface and create a mechanical union between the cement and the bonding agent/composite resin that is comparable to the one created between etched enamel and the composite resin [5,6].Resin-modified glass ionomer (RMGI) cement has recently largely supplanted regular glassionomer cement due to certain advantages, including greater chemical and physical properties[7].

RMGI and composite resin have differing thermal expansion coefficients, thus some drop in the bond strength values is likely, despite research indicating the effectiveness of chemical bonding for the longevity of restorations.Thus, a few ways to improve the RMGI surface's micromechanical bonding were used. Aluminium oxide (Al_2O_3) particles used in the air abrasion process[8,9] and acid etching, the traditional method[10], both increase surface energy and the area for bonding, which increases bond strength. Due to the inconsistent findings of earlier research on the use of acid etching on RMGI bond strength, time loss, restrictions on the expiration date of acid etchants, and the sensitivity of their method, lasers have been used to improve surface roughness[7] .

Effect of differernt methods of surface treatment of the RMGIC on microleakage has not been previously compared. Hence the present study was planned to compare the effect of different surface pretreatments of RMGIC on microleakage when used in sandwich technique.

MATERIAL AND METHODOLOGY:

This was an in-vitro experimental study.

Sample preparation:

35 cylindrical samples of RMGI with A2 shade are prepared using moulds made of putty. After mixing the powder and liquid according to the manufacturer's instructions, a layer of mixed material is placed inside a mould and cured for 20 seconds with a light-curing unit at 400mW/cm2 intensity [fig.1]

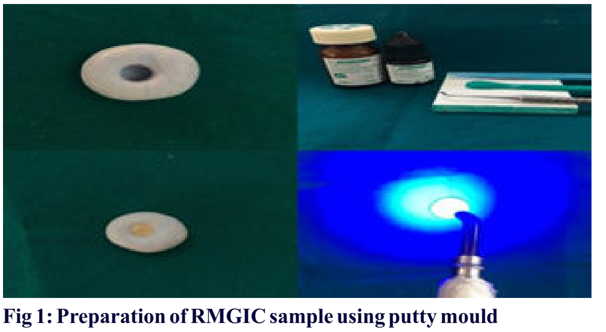

Fig 1: Preparation of RMGIC sample using putty mould

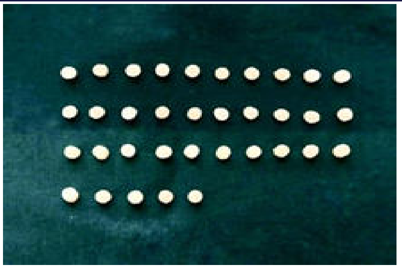

Fig:2 RMGIC samples

The putty mould was cut using a surgical blade. The extracted samples[fig.2] will randomly be divided into five groups (n=7)

METHODOLOGY:

- Group 1: (control group): No surface preparation was performed(fig.3)
- Group 2: Acid etching with 37% phosphoric acid (fig.4)
- Group 3: The surfaces of the samples were roughened with 30-μm Al2O3 particles for 10 seconds; then, the samples were irrigated for 10 seconds with distilled water, and the excess water was removed with a piece of wet cotton pellet.(fig.5)
- Group 4: The surfaces of the samples were roughened with a rough diamond bur for 3 seconds at high-speed under water spray. Then, the samples were irrigated for 10 seconds with distilled water, and excess water was removed with a wet cotton pellet.(fig.6)
- Group 5: The surfaces of the samples were roughened using Er:YAG laser with MZ8 tip measuring 800 μm in diameter, 0.502-mm2 spot-size, 2740-nm wavelength, 1.5 W power, 10-Hz frequency, 8% water output, and 4% air output at 1-mm distance from the surface for 10 seconds with 150-mj energy in micro short pulse mode The samples were then irrigated for 10 seconds with distilled water, and the excess water was removed with a wet cotton pellet (fig.7)

Fig: 3 Group 1 control group

Fig:4 Group 1: sample treated using Acid etch

Fig 5:Group 2:samples treated with air abrasion method using AL2O3 particles

Fig 6: Group 3- samples treated with dental bur

Fig 7: Group 4- samples treated with Er:YAG laser

Two samples from each group were randomly examined under a profilometer to evaluate the surface microscopically.(fig.8)

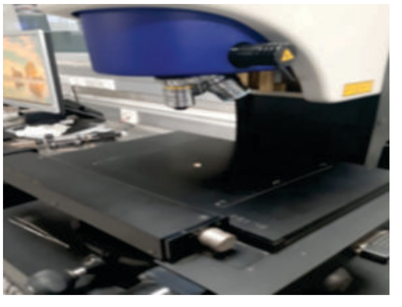

Fig 8: profilometer evaluation for surface roughness

A bonding layer was then applied on the surfaces of all the samples according to the manufacturer's instructions and cured for 10 seconds with 400 mW/cm 2 intensity. Composite resin with A1 shade will be applied in one layer of 2mm and cured for 40 seconds (fig.9)

Fig 9: Composite restoration done on the samples pre-treated using different methods.

To simulate the clinical condition and absorbing water, the samples were subjected to distilled water at 37°C for 24 hours. The samples were then soaked in 1% methylene blue dye solution for 48 hours and rinsed under running water and then sectioned longitudinally using a diamond disk to evaluate the microleakage between the two restorative materials(fig.10) The specimens were observed under the Stereo microscope between magnifications of 2.5* 10× for microleakage observations(fig.11)

Fig 10: Sectioning of the samples for microscopic examination

Fig 11: Stereo microscopic examination under magnifications of 2.5* 10× for microleakage observations

The maximum degree of dye penetration was calculated according to the following score:
0 = No dye penetration; 1 = dye penetration less than one third width. 2 = dye penetration beyond the one third of width. 3 = Dye penetration include the entire width or surface[11]

RESULTS

Surface roughness:

The mean Ra values for Group 1 was 0.1989 ± 0.0157, Group 2 was 0.4248 ± 0.0046, Group 3 was 0.2878 ± 0.0385, Group 4 was 0.4814 ± 0.0339 and Group 5 was 0.5484 ± 0.0193. This difference in the mean Ra values between 5 groups showed statistically significant difference at p<0.001. [Refer table.1]

Multiple comparison of mean differences between groups revealed that the Group 5 showed significantly higher mean Ra values as compared to other groups and the mean differences were statistically significant at p<0.001. This was then followed next by Group 4 which showed significantly higher mean Ra values as compared to Group 2, 3 and Group 1 at p=0.002 and p<0.001 respectively. This was later followed next by Group 2 which showed significantly higher mean Ra values as compared to Group 3 and Group 1 and the mean differences were statistically significant at p<0.001. Lastly, Group 3 also showed significantly higher mean Ra values as compared to Group 1 and the mean difference was statistically significant at p<0.001. This infers that the mean Ra values was significantly highest in Group 5, followed by Group 4, Group 2, Group 3 and least in Group 1. [Refer table.2]

Table 1:Comparison of mean Surface Roughness [Ra] values between 5 groups using One-way ANOVA Test

Groups	N	Mean	SD	Min	Max	p-value
Group 1	7	0.1989	0.0157	0.180	0.222	<0.001*
Group 2	7	0.4248	0.0046	0.419	0.431	
Group 3	7	0.2878	0.0385	0.227	0.336	
Group 4	7	0.4814	0.0339	0.437	0.526	
Group 5	7	0.5484	0.0193	0.528	0.580	

Table 2: Multiple comparison of mean difference in the Ra values between 5 groups using Tukey's Post hoc Test

(I) Groups	(J) Groups	Mean Diff. (I-J)	95% CI for the Diff.		p-value
			Lower	Upper	
Group 1	Group 2	-0.2259	-0.2656	-0.1863	<0.001*
	Group 3	-0.0889	-0.1286	-0.0492	<0.001*
	Group 4	-0.2825	-0.3222	-0.2428	<0.001*
	Group 5	-0.3495	-0.3892	-0.3098	<0.001*
Group 2	Group 3	0.1371	0.0974	0.1768	<0.001*
	Group 4	-0.0566	-0.0963	-0.0169	0.002*
	Group 5	-0.1235	-0.1632	-0.0838	<0.001*
Group 3	Group 4	-0.1936	-0.2333	-0.1540	<0.001*
	Group 5	-0.2606	-0.3003	-0.2209	<0.001*
Group 4	Group 5	-0.0670	-0.1066	-0.0273	<0.001*

The mean Rq values for Group 1 was 0.2541 ± 0.0083, Group 2 was 0.5342 ± 0.0801, Group 3 was 0.3556 ± 0.0109, Group 4 was 0.6420 ± 0.0111 and Group 5 was 0.8349 ± 0.0534. This difference in the mean Rq values between 5 groups showed statistically significant difference at p<0.001. [Refer table.3]

Multiple comparison of mean differences between groups revealed that the Group 5 showed significantly higher mean Ra values as compared to other groups and the mean differences were statistically significant at p<0.001. This was then followed next by Group 4 which showed significantly higher mean Ra values as compared to Group 2, 3 and Group 1 at p=0.001 and p<0.001 respectively. This was later followed next by Group 2 which showed significantly higher mean Ra values as compared to Group 3 and Group 1 and the mean differences were statistically significant at p<0.001. Lastly, Group 3 also showed significantly higher mean Ra values as compared to Group 1 and the mean difference was statistically significant at p=0.001. This infers that the mean Ra values was significantly highest in Group 5, followed by Group 4, Group 2, Group 3 and least in Group 1. [Refer table.4]

Table 3: Comparison of mean Surface Roughness [Rq] values between 5 groups using One-way ANOVA Test

Groups	N	Mean	SD	Min	Max	p-value
Group 1	7	0.2541	0.0083	0.238	0.263	<0.001*
Group 2	7	0.5342	0.0801	0.424	0.651	
Group 3	7	0.3556	0.0109	0.344	0.375	
Group 4	7	0.6420	0.0111	0.628	0.657	
Group 5	7	0.8349	0.0534	0.733	0.897	

Table 4: Multiple comparison of mean difference in the Rq values between 5 groups using Tukey's Post hoc Test

(I) Groups	(J) Groups	Mean Diff. (I-J)	95% CI for the Diff.		p-value
			Lower	Upper	
Group 1	Group 2	-0.2802	-0.3481	-0.2123	<0.001*
	Group 3	-0.1015	-0.1694	-0.0336	0.001*
	Group 4	-0.3880	-0.4558	-0.3201	<0.001*
	Group 5	-0.5809	-0.6488	-0.5130	<0.001*
Group 2	Group 3	0.1787	0.1108	0.2465	<0.001*
	Group 4	-0.1078	-0.1757	-0.0399	0.001*
	Group 5	-0.3007	-0.3686	-0.2328	<0.001*
Group 3	Group 4	-0.2864	-0.3543	-0.2185	<0.001*
	Group 5	-0.4794	-0.5473	-0.4115	<0.001*
Group 4	Group 5	-0.1929	-0.2608	-0.1251	<0.001*

Stereomicroscopic Analysis For Microleakgae

According to scoring criteria: (Refer: fig 14)
Group 5 = 0 (No dye penetration)
Group 4 = 1 (dye penetration less than one third width)
Group 3 = 2 (dye penetration more than one third width)
Group 2 = 1 (dye penetration less than one third width)
Group 1 = 2 (dye penetration more than one third width)

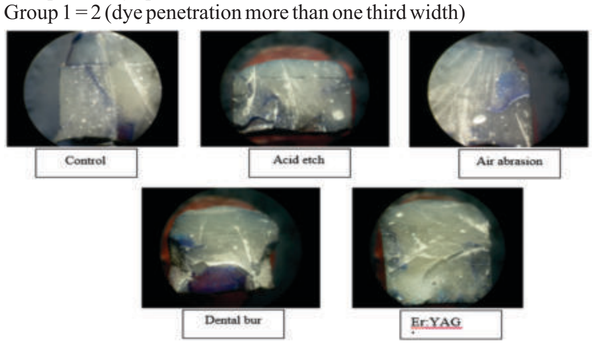

Fig:14: Stereo microscopic analysis for micro leakage in different groups

DISCUSSION:

Fluid infiltration or micro leakage during restoration is a sign of a bond failure between them, which can happen for a number of reasons, including polymerization shrinkage, material incompatibility, and thermal changes in a given material over time.Different RMGI surface preparation techniques increase the material's surface roughness, which expands the area available for bonding. The results of etching the samples' surfaces with 37% phosphoric acid were lower than those of the control group. This change, though, was not substantial. The results of earlier investigations were consistent with the decrease in bond strength that occurred after the application of phosphoric acid. The two independent reactions that cause RMGI to harden are 1) a resin polymerization that occurs very quickly as a result of photochemical activation, and 2) the slower acid-base reaction between the glass powder and an organic acid.The application of early acid-etching would cause some ion release particularly in the surface areas of the glass, and reduce the overall strength of the glass lattice while also removing un-reacted chains because it is impractical to wait for a long time while the patient is present[12].

Bur roughening will produce mechanical pores and strengthen the bond. The pre-treatment with a carbide or diamond bur boosted the bond strength.The RMGI surface is more abraded and roughened than the laboratory composite resin that was blasted by a bur due to the lower amount of uncured methacrylate monomers.Bur abrasion produces a smear layer that is not present in the other groups which causes debonding in some surface areas[13].

In order to facilitate the formation of resin micro-tags for the adhesive bonding agent and composite resin, the RMGI surface created by air abrasion has homogeneous micro-porosities throughout the surface. Air abrasion removes some surface layers, much like bur roughening does. However, because Al2O3 particles are so tiny and the present study used the smallest size possible, there aren't many smear layers and the surface changes are uniform and microscopic[7,14].

Due to the conflicting findings of earlier research on the use of acid etching on RMGI bond strength, time loss, restrictions on the expiration date of acid etchants, and the sensitivity of their method, lasers have been used to improve surface roughness.[7].The initial set of RMGIC is due to the formation of a polymerization matrix while the acid-base reaction hardens and strengthens the matrix formed slowly.The set cement will have two inter-penetrating matrices, i.e., the ionic matrix from the acid-base reaction and the polymerization matrix from the free-radical reaction.Therefore, it seems that although cement is not permeable to acid after initial setting due to higher resin content, laser can still penetrate into the ionic matrix and adsorb to water or hydroxyl groups of the material's structure and induce micro-irregularities in the surface through its hydrokinetic effect increasing the bond strength[15].

CONCLUSION

The present study indicated an increase in the surface roughness in the RMGIC after laser treatment while there was not any significant surface topographic alteration in the other groups.Therefore, microlekage was significantly less in the laser-etched group leading to increased bond strength and homogenous restorations.Though used as gold standard premature use of acid etching on RMGI in the clinic could harm its bond strength to the resin.However, the use of laser is limited due to its high cost and maintenance.

Acknowledgements:

The authors would like to thank the institute D A Pandu Memorial R V Dental college for extending full support during the study and also would like to thank the statistician for helping with the analysis of the study.

REFERENCES:

1) Taori P, Nikhade P, Chandak M, et al. (October 09, 2022) Comparative Evaluation of Microleakage in Class II Restorations Using Open- and Closed-Sandwich Techniques With Zirconomer as an Intermediate Material: An In-Vitro Study. Cureus 14(10): e30109. DOI 10.7759/cureus.30109
2) Aljdaimi A, Devlin H, Dickinson M. Effect of the Er: YAG laser on the shear bond strength of conventional glass ionomer and Biodentine™ to dentine. Eur J Dent 2018;12:380-5.
3) Nijhawan C, Jasuja P, Sharma A, Khurana H, Gakhar E. Comparative evaluation of shear bond strength of a traditional composite and ACTIVA BioACTIVE after enamel preparation with Er:YAG laser and conventional acid etching: An in vitro study. J Dent Lasers 2019;13:44-8
4) Gupta R, Mahajan S. Shear Bond Strength Evaluation of Resin Composite Bonded to GIC Using Different Adhesives. J Clin Diagn Res. 2015 Jan;9(1):ZC27-9. doi: 10.7860/JCDR/2015/10224.5462. Epub 2015 Jan 1. PMID: 25738081; PMCID: PMC4347172.
5) McLean JW, Powis DR, Prosser HJ. The use of glass ionomer cements in bonding composite resin to dentine. Brit Dent J. 1985;158:410-14.
6) Zanat RL, Navarro FL, Ishikiriama A, Junior MHSS, Delazari RCMF. Bond Strength Between Resin Composite and Etched and Non-etched Glass Ionomer.Braz Dent J. 1997;8(2):73-78
7) Zakavi F, Gholizadeh S, Dibazar S, Esmaeili M. A Comparison of Laser and Mechanical Surface Pretreatment Methods on Shear Bond Strength of Resin Composite to Resin-Modified Glass Ionomer. J Dent (Shiraz). 2023 Mar;24(1 Suppl):103-111. doi: 10.30476/dentjods.2022.92281.1624. PMID: 37051498; PMCID: PMC10084561.
8) Kumar U, Dharmani CK, Singh S, Logani A, Shah N. Effect of Air Abrasion Preconditioning on Microleakage in Class V Restorations Under Cyclic Loading: An In-vitro Study. J Clin Diagn Res. 2014 May;8(5):ZC29-32. doi: 10.7860/JCDR/2014/7029.4363. Epub 2014 May 15. PMID: 24995240; PMCID: PMC4080061.
9) Ghubaryi AAA, Ingle N, Basser MA. Surface treatment of RMGIC to composite resin using different photosensitizers and lasers: A bond assessment of closed Sandwichrestoration. Photodiagnosis Photodyn Ther. 2020; 32:101965
10) Pamir T, Şen BH, Evcin Ö. Effects of etching and adhesive applications on the bond strength between composite resin and glass-ionomer cements. J Appl Oral Sci. 2012; 20:636-42.
11) horoushi M, Karvandi TM, Kamali B, Mazaheri H. Marginal microleakage of resin-modified glass-ionomer and composite resin restorations: Effect of using etch-and-rinse and self-etch adhesives. Indian J Dent Res 2012;23:378-83
12) Welch D, Seesengood B, Hopp C. Surface Treatments that Demonstrate a Significant Positive Effect on the Shear Bond Strength of Repaired Resin-modified Glass Ionomer. Oper Dent. 2015;40(4):403-409. doi:10.2341/13-314-L
13) Kimyai S, Mohammadi N, Navimipour EJ, Rikhtegaran S. Comparison of the effect of three mechanical surface treatments on the repair bond strength of a laboratory composite. Photomed Laser Surg. 2010; 28: S25-S30
14) Oztas N, Alaçam A, Bardakcy Y. The effect of air abrasion with two new bonding agents on composite repair. Oper Dent. 2003; 28: 149-154
15) Nandana KL, Sai Sankar, Manoj Kumar: Comparative evaluation of microleakage using three variables of glass-ionomer cement in primary and permanent teeth: an in vitro study. J Interdiscip Dent. 2016, 6:110-5.10.4103/2229-5194.201646
16) Patel V, Purohit P, Sanghvi Z, Choksi S, Patel P, Patel N. An in vitro study of comparative evaluation of acid etching of Glass Ionomer Cement Surface and resin modified Glass Ionomer Cement on the microleakage of sandwich restorations. J Adv Med Dent Scie Res 2021;9(1):27-30
17) Otsuka E, Tsujimoto A, Takamizawa T, et al. Influence of surface treatment of glass-ionomers on surface free energy and bond strength of resin composite. Dent Mater J. 2013;32(5):702-708. doi:10.4012/dmj.2013-117
18) Li J, Liu Y, Liu Y, Söremark R, Sundström F. Flexure strength of resin-modified glass ionomer cements and their bond strength to dental composites. Acta Odontol Scand 1996; 54: 55-58.