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Original Research

Comparative Clinical Evaluation of Resin Modified Glass Ionomer Cement, Microfilled Composite and a New Glass Ionomer Based Restorative System Equia in Restoration of Non-Carious Cervical Lesions: An In Vivo Study

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ABSTRACT:

Aim: Comparison of the clinical performance of Resin modified Glass Ionomer Cement, EQUIA and Microfilled Composite as a restorative material for non-carious cervical lesions (NCCLs). **Materials and methods:** Healthy patients with a minimum of three NCCLs following inclusion and exclusion criteria were selected. All three restorations i.e. Resin modified Glass Ionomer Cement, EQUIA and Microfilled Composite were done in the cervical defects randomly under isolation. The restorations were clinically evaluated with magnifying loupes (2.5 X) at the end of 1 month, 6 months and 1 year for retention, marginal discoloration, marginal adaptation, anatomic form, surface roughness, secondary caries and postoperative sensitivity of the restorations according to modified United States Public Health Service (USPHS) criteria. **Statistical analysis:** Data analysis was done using SPSS 16 software. Z-test was used to compare the proportions. **Results:** EQUIA showed a significantly lower retention rate when compared with Microfilled composite and RMGIC *(P<0.05)* by the end of one year. With regards to surface texture, RMGIC showed significantly higher surface roughness when compared with Microfilled composite and EQUIA at 6 months and one year follow up. *(P<0.05)* In all other criteria, no significant difference was found between the three restorative materials in any follow-up evaluations. **Conclusion:** Microfilled composite showed an overall better performance than the other two materials. EQUIA has potential to be used as a restorative material in NCCLs, but conclusive recommendations require more clinical studies and longer follow up periods.

Keywords: NCCLs;EQUIA; GIC; RMGIC

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INTRODUCTION

Non-carious cervical lesions (NCCLs) are characterized by loss of tooth substance at the cementoenamel junction and include all lesions which occur at the neck of the tooth.[1] The management of NCCLs should begin with the least invasive technique like controlling the causative factors and extend to more invasive procedures like restoration.

The success of dental restorations depends on the type of restorative material used. Many materials and techniques have been tested for the best results. The ideal material should bond well, be tooth-coloured and abrasion resistant.[2] Micromechanical retention, preservation of tooth structure, esthetics, and function are considered when selecting restorative material.[3]

Conventional Glass ionomer cement (GIC) has vast clinical applications in restoring NCCLs. It can chemically adhere to the dental substrate and release fluoride, reducing the risk of microleakage and secondary caries formation. However, its initial water sensitivity during the setting reaction for the first 24 hrs. and low fracture toughness are its major drawbacks. The handling characteristics of glass ionomers are inferior, with short working times and long setting times.[4]

Composite resin materials are the most used restorative materials due to their aesthetics and high abrasion resistance. In NCCLs, Microfilled composites are indicated because of their low modulus of elasticity and ability to adapt to micro and macro-structural defects in the cavity. However, there are major concerns associated with composites, such as polymerization shrinkage, problems in bonding to sclerotic dentin and technique-sensitive placement.[5]

Modern restorative systems combine these two materials i.e. GIC and Composite, to harness the benefits of both and this includes EQUIA , the two-stage restorative system, introduced by GC Corp that consists of a high-viscosity GIC component and a nanofilled composite-resin coating (G Coat Plus).[6] Studies have demonstrated that the surface application of G-Coat plus reduces water absorption and improves the wear resistance of Fuji IX GP EXTRA. It also serves to occlude surface cracks and increase the wear resistance and toughness along with translucency and better marginal seal.[7]

Earlier studies have compared the clinical performance of RMGIC, Composites, Compomers etc.[8] Currently, there are very few independent studies evaluating EQUIA's performance in NCCLs. The non-carious cervical lesion is a multifactorial disease. All the dependent variables cannot be simulated in vitro. So In vivo studies are crucial for the evaluation of material performance.

The objective of this study is to compare the clinical performance of Resin Modified Glass Ionomer Cement (RMGIC), Microfilled composite and EQUIA in NCCLs. The null hypothesis is that resin-modified Glass Ionomer Cement (RMGIC), Microfilled composite and EQUIA will not differ in their performance clinically.

MATERIALS AND METHODS

This study was performed on patients visiting the OPD of Conservative Dentistry and Endodontics in HSJIDS, PU, Chandigarh, with a minimum of three NCCLs in the same quadrant in the age group between 20-60 years, indicated for restoration were selected.

Inclusion Criteria

- Patients with at least three non-carious cervical lesions on permanent maxillary or mandibular teeth, indicated for restoration with depth ranging from 1-3 mm.[9]

Exclusion Criteria

- Patients with poor oral hygiene and severe periodontal disease.
- Patients with bruxism and rampant caries.
- Fractured, carious, discoloured and visibly cracked teeth.
- Any gross oral pathology.

Procedural steps

All the subjects underwent oral prophylaxis two weeks before the placement of restorations. All the restorations were placed under isolation with a gingival retraction cord, cotton rolls and saliva ejector. In every patient, all three types of materials were placed following the manufacturer's instructions(figure 2a).

GROUP 1: RESIN MODIFIED GLASS IONOMER CEMENT (FUJI II LC)

The lesion for restoration was conditioned with GC cavity conditioner for 10 secs, washed and dried, and then filled with resin modified glass ionomer cement (FUJI II LC). A final coat of GC Fuji varnish was applied and air-blown.

GROUP 2: EQUIA (FUJI IX GP EXTRA AND G-COAT PLUS)

The lesion was conditioned with GC cavity conditioner for 10 secs, washed and dried then filled with Fuji IX GP Extra restorative material. Finally, the surfaces of restorations were coated with G coat plus by applicator tip and it was light-cured for 20 sec.

GROUP 3: MICROFILLED COMPOSITE (HELIOMOLAR)

Acid etching was done for 15 seconds with IvoclarVivadent N –Etch etchant, washed and dried. Bonding agent, Tetric N Bond was applied followed by placement of resin material.

RESULTS

Each patient received 3 restorations, one with each material. Finishing and polishing were done. After that, the patients were recalled at 1 month, 6 months and 1 year and evaluated and graded for retention, marginal staining, marginal adaptation, surface texture, anatomic form, secondary caries and post-operative sensitivity according to modified USPHS criteria by a blinded investigator. Comparisons were restricted to Alpha proportions since the proportion of Bravo and Charlie were almost zero in each case. Z-test was used to compare the proportions. [Table 1-7]

TABLE I: COMPARISON OF RETENTION BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Retention	Proportion of materials	Sample size	Z- test	p-value
1 Month	$p_1=1$	$n_1=32$	$Z_{12}=0$	>.5(NS)
	$p_2=1$	$n_2=32$	$Z_{13}=0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
6 Months	$p_1=0.9688$	$n_1=32$	$Z_{12}=1.397$	0.162

	p_2=0.875	n_2=32	Z_{13}=-1.008	0.313
	p_3=1	n_3=32	Z_{23}=-2.066	0.039*
1 Year	p_1=0.9355	n_1=31	Z_{12}=2.53	0.011*
	p_2=0.6786	n_2=28	Z_{13}=-0.033	0.974
	p_3=0.9375	n_3=32	Z_{23}= -2.586	0.01*

*P<0.05 statistically significant, P>0.05 non-significant, NS

Comparison of retention between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month had a P value more than 0.5 suggesting no statistical significance. Comparison of retention between Group 1 and 2, Group 1 and 3 and Group2 and 3 at 6 months had a P value 0.162, 0.313 and 0.039 respectively suggesting no statistical significance expect between group 2 and 3 suggesting statistical significance. Comparison of retention between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one year had a P value 0.011, 0.974 and 0.01 respectively suggesting statistical significant difference between group 1 and 2 and group 2 and 3.

TABLE II: - COMPARISON OF MARGINAL ADAPTATION BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP 2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Marginal Adaption	Proportion of materials	Sample size	Z- test	p-value
1 Month	p_1=1	n_1=32	Z_{12}=0	>.5
	p_2=1	n_2=32	Z_{13}=0	>.5
	p_3=1	n_3=32	Z_{23}=0	>.5
6 Months	p_1= 0.9677	n_1=31	Z_{12}= 0.073	0.942
	p_2= 0.9643	n_2=28	Z_{13}= -1.024	0.306
	p_3=1	n_3=32	Z_{23}=- 1.078	0.281
1 Year	p_1= 0.8571	n_1=28	Z_{12}= -1.126	0.260
	p_2= 0.7222	n_2=18	Z_{13}=-0.952	0.341
	p_3= 0.9333	n_3=30	Z_{23}= -2.006	0.055

*P<0.05 statistically significant, P>0.05 Non Significant, NS

Comparison of marginal adaption between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month, 6 months and one year had a P value more than 0.5 suggesting no statistical significance.

TABLE III: - COMPARISON OF SURFACE TEXTURE BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Surface texture	Proportion of each materials	Sample size	Z- test	p-value
1 Month	p_1=1	n_1=32	Z_{12}=0	>.5
	p_2=1	n_2=32	Z_{13}=0	>.5
	p_3=1	n_3=32	Z_{23}=0	>.5
6 Months	p_1= 0.8710	n_1=31	Z_{12}= -1.969	0.049*
	p_2= 1	n_2=28	Z_{13}= -2.01	0.036*
	p_3=1	n_3=32	Z_{23}=0	>.5
1 Year	p_1= 0.7586	n_1=29	Z_{12}= -2.317	0.020*
	p_2= 1	n_2=19	Z_{13}= -2.86	0.004*
	p_3= 1	n_3=30	Z_{23}= 0	>0.5

*P<0.05 statistically significant, P>0.05 Non-Significant, NS

Comparison of surface texture between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month had a P value more than 0.5 suggesting NO statistical significance. Comparison of retention between Group 1 and 2, Group 1 and 3 and Group2 and 3 at 6 months had a P value 0.049, 0.036, and >.5 suggesting statistical significance expect between group 2 and 3 suggesting no statistical significance. Comparison of retention between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one year had a P value0.020, 0.004 and >0.5 suggesting the statistical significant difference between group 1 and 2 and group 1 and 3 expect between group 2 and 3 suggesting no statistical significance.

TABLE IV: - COMPARISON OF MARGINAL DISCOLORATION BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP 2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Marginal discoloration	Proportion of each materials	Sample size	Z- test statistic	p-value
1 Month	$p_1=1$	$n_1=32$	$Z_{12}=0$	>.5
	$p_2=1$	$n_2=32$	$Z_{13}=0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
6 Months	$p_1= 1$	$n_1=31$	$Z_{12}= 0$	>.5
	$p_2= 1$	$n_2=28$	$Z_{13}= 0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
1 Year	$p_1= 0.9655$	$n_1=29$	$Z_{12}= - 0.818$	0.413
	$p_2= 1$	$n_2=19$	$Z_{13}= -0.024$	0.981
	$p_3= 0.9667$	$n_3=30$	$Z_{23}= 0.804$	0.421

*P<0.05 statistically significant, P>0.05 Non Significant, NS

Comparison of marginal discoloration between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month, 6 months and one year had a P value more than 0.5 suggesting no statistical significance.

Table V: COMPARISON OF POSTOPERATIVE SENSITIVITY BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP 2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Postoperative sensitivity	Proportion of each materials	Sample size	Z- test	p-value
1 Month	$p_1=1$	$n_1=32$	$Z_{12}=0$	>.5
	$p_2=1$	$n_2=32$	$Z_{13}=0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
6 Months	$p_1= 1$	$n_1=31$	$Z_{12}= 0$	>.5
	$p_2= 1$	$n_2=28$	$Z_{13}= 0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
1 Year	$p_1= 1$	$n_1=29$	$Z_{12}= 0$	>.5
	$p_2= 1$	$n_2=19$	$Z_{13}= 0$	>.5
	$p_3= 1$	$n_3=30$	$Z_{23}= 0$	>.5

Comparison of postoperative sensitivity between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month, 6 months and one year had a P value more than 0.5 suggesting no statistical significance.

TABLE VI: - COMPARISON OF ANATOMIC FORM BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP 2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Anatomic form	Proportion of each material	Sample size	Z- test	p-value
1 Month	$p_1=1$	$n_1=32$	$Z_{12}=0$	>.5
	$p_2=1$	$n_2=32$	$Z_{13}=0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
6 Months	$p_1= 0.9677$	$n_1=31$	$Z_{12}= 0.073$	0.942
	$p_2= 0.9643$	$n_2=28$	$Z_{13}= -1.024$	0.306
	$p_3=1$	$n_3=32$	$Z_{23}= -1.078$	0.281
1 Year	$p_1= 0.8966$	$n_1=29$	$Z_{12}= -0.572$	0.567
	$p_2= 0.9444$	$n_2=19$	$Z_{13}= -0.507$	0.612
	$p_3= 0.9333$	$n_3=30$	$Z_{23}=0.154$	0.878

Comparison of anatomic form between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month, 6 months and one year had a P value more than 0.5 suggesting no statistical significance.

TABLE VII: - COMPARISON OF SECONDARY CARIES BETWEEN THREE GROUPS (GROUP 1-RMGIC, GROUP 2-EQUIA AND GROUP 3-MICROFILLED COMPOSITE) AT DIFFERENT TIME INTERVALS.

Secondary caries	Proportion of each material	Sample size	Z- test	p-value
1 Month	$p_1=1$	$n_1=32$	$Z_{12}=0$	>.5
	$p_2=1$	$n_2=32$	$Z_{13}=0$	>.5
	$p_3=1$	$n_3=32$	$Z_{23}=0$	>.5
6 Months	$p_1= 1$	$n_1=31$	$Z_{12}= 0$	>.5

	p_2= 1	n_2=28	Z_{13}= 0	>.5
	p_3=1	n_3=32	Z_{23}=0	>.5
1 Year	p_1= 1	n_1=29	Z_{12}= 0	>.5
	p_2= 1	n_2=19	Z_{13}= 0	>.5
	p_3= 1	n_3=30	Z_{23}= 0	>.5

Comparison of secondary caries between Group 1 and 2, Group 1 and 3, and Group 2 and 3 at one month, 6 months and one year had a P value more than 0.5 suggesting no statistical significance.

Figure 1: Non carious cervical lesions filled with RMGIC, EQUIA and Microfilled composite restorations. a) preoperative images b) immediate post operative images.

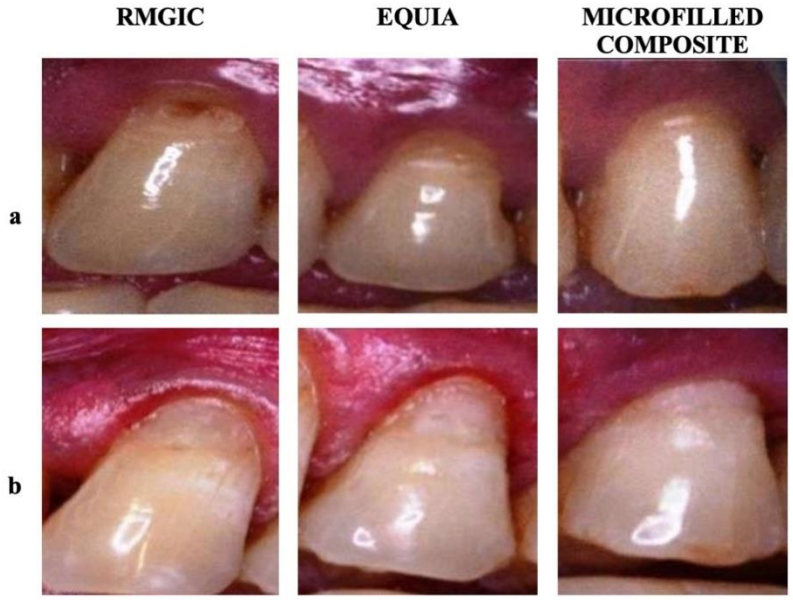

Figure 2: Follow up images. a) 1 month follow-up, b) six month follow up and, c) 1 year follow up.

DISCUSSION

The prevalence of NCCLs increases as the ageing population increases. NCCLs are of multifactorial origin and present with significant changes in the surface and structure of the dentin including hypermineralization, sclerotic dentin, and obliteration of tubules. The exact mechanism of their formation is still unknown.[10]

Choosing a suitable restorative material for cervical lesions is important. The material should have good aesthetics, abrasion resistance, and adequate adhesion to dentine. The most commonly used materials to restore these NCCLs are Glass ionomer cement, Resin-modified Glass ionomers, Compomers, and Microfilled composite resin. But there are no standard guidelines established as to which best material of all.[11]

Burrow et al found resin-modified GIC to perform better than composite restorations over three years.[12] Santiago et al found similar results when they compared RMGIC to composite resin over 2 years.[13] On the contrary, Brackett et al found no significant difference in the rate of retention of Microfilled composite and RMGIC.[14]

EQUIA (GC, America) is a new glass ionomer restorative system. It is a combination of a self-adhesive, chemically cured, highly filled GIC (Fuji IX GP Extra, GC) and a self-adhesive, light cured, filled resin surface sealant (G-Coat Plus, GC). Molina et al found EQUIA to have significantly higher diametral, tensile, flexural and compressive strengths as compared to Fuji IX gold label without a coating.[15]

This study compared the clinical performance of Glass Ionomer Cement, Microfilled composite resin, and EQUIA for treating Non-Carious Cervical Lesions (NCCLs) over one year.

Various evaluation systems are used to rate the clinical performance of restorative materials. The commonly used system USPHS, developed by Cvar and Ryge in 1971 has been modified over the years as per the requirement and study design.[16] In the current study modified USPHS criteria were used for the clinical evaluation of restorations at 1 month, 6 months and 12 months. Although some important factors such as oral hygiene index and, the number of decayed, missing and filled teeth are not considered in these criteria, they are the only criteria existing for the evaluation of restorations for the long term.[17]

Comparing the retention rates, at one-month follow-up, no significant difference was found between RMGIC, Microfilled composite and EQUIA [Table I, Figure 2a]. At 6 months, Microfilled composite showed a significantly better retention rate compared to EQUIA but no significant difference was found between RMGIC and EQUIA group and between RMGIC and Microfilled Composite (Figure 2b and 2c). EQUIA group by the end of the year showed a significantly lowest retention rate when compared with RMGIC and Microfilled composite. [Table I]

Much of the success of Microfilled resin must be attributed to the etched enamel resin bond encountered along the occlusal margins of these cervical restorations. Along with this the greater amount of resin matrix contents of the Microfilled composite appears to reduce the elastic modulus of the restoration, permitting it to flex rather than being de-bonded during cervical flexure.[18] Similar to the present study, Folwaczny et al found no loss of Tetric restorations (composite) at 24 months, compared to a 6-10% loss for RMGIC.[8]

In the present study, Microfilled composite showed the best marginal adaptation of the three materials, although the results were not statistically significant. [Table II] Fatigue cracks caused by tensile forces are the probable cause of chipping and marginal breakdown in cervical restorations. The flexural fatigue limit and the restrained fracture strength of RMGIC are significantly lower than composites.[19] EQUIA performed well for six months, but after a year, marginal adaptation deteriorated possibly due to wear of surface protection. [Figure 2c]

Surface roughness influences the retention of stains, plaque, and esthetics. RMGIC showed significantly greater surface roughness compared to Microfilled composite and EQUIA at 6- month and 1-year follow-ups. [Table III] There was no significant difference in the surface roughness of EQUIA and Microfilled composite at any of the follow ups. In a similar study by Auj Y et al., RMGIC (Fuji II LC) and highly viscous GIC (Fuji IX GP Extra) had significantly rougher surfaces than composites after polishing.[20]

No significant difference was seen in the marginal staining of three restorative materials at any follow-up periods in the present study. [Table IV] However, at the end of one year Microfilled composite and RMGIC showed a slight increase in marginal discolouration compared to EQUIA. This could be due to the marginal gaps formed because of polymerization shrinkage. None of the EQUIA restorations showed marginal discolouration. Like all cement, glass ionomer also shrinks on the setting. However, the addition of moisture for the setting reaction compensates for this shrinkage to some extent. Hence, GIC shows comparatively less marginal staining as compared to other restorative materials.[19] [Table IV]

None of the restorations showed postoperative sensitivity at any time in the present study. Similar to the current study, Santiago et al found no postoperative sensitivity with RMGIC and composite till one year.[13] [Table V]

In the present study, no secondary caries were found by the end of 1 year. [Table VII] Results of one year can provide a vital piece of information about the clinical performance of restorative materials, but this study period is not sufficient for secondary caries development.[21]

CONCLUSION

The management of NCCLs has been a matter of debate and intense investigation because of the unique nature of the problem. The results have shown that EQUIA showed a significantly poor retention rate at the end of 1 year compared to Microfilled composite and RMGIC. With regards to surface texture, RMGIC showed significantly higher surface roughness when compared with Microfilled composite and EQUIA at the end of one year.

In all other criteria, no significant difference was found between the three restorative materials. Clinically, Microfilled composite showed an overall better performance than the other two materials. EQUIA does show it has potential to be utilized as a restorative material in NCCLs, but to have a conclusive recommendation, more clinical studies and longer follow-up periods may be required.

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