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Original Article

Dentistry Section

Comparative Evaluation of Antimicrobial Efficacy of Resin-Modified Glass Ionomers, Compomers and Giomers – An *Invitro* Study

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ABSTRACT

Background: Dental restorative materials, especially those applied in direct contact with the contaminated substrate, should have appropriate antibacterial activity in order to prevent residual bacteria from continuing their metabolic activity in addition to impairing new bacteria from reaching the tooth-restoration interface.

Aim: To determine the antibacterial efficacy of three different restorative materials against the common cariogenic microorganism i.e., *Streptococcus mutans*.

Materials and Methods: Three different restorative materials were evaluated in this study: Giomer (Beautifil), Compomer (F2000) & Resin modified Glass ionomer (Fuji II LC) for their anti microbial efficacy against *Streptococcus mutans* by standard agar diffusion method and zones of inhibition for each restorative material were calculated.

Statistical Analysis: Inhibition zones around each restorative material were measured and values were subjected to one-way ANOVA with least square difference (LSD) Post-hoc test.

Results: The mean inhibitory zones for Resin modified glass ionomers, Giomers & Compomers ranged from 10.1 – 6.90mm. Fuji II LC exhibited the highest mean inhibitory zone of 10.1 ± 1.97 for *S.mutans*. Beautifil exhibited mean inhibitory zone of 8.20 ± 1.62, whereas F2000 showed the least mean inhibitory zone of 6.90 ± 1.29.

Conclusion: Based on the inhibitory zones of three restorative materials, Fuji II LC is recommended as the best restorative material among the three tested restorative materials.

Keywords: Antibacterial activity, Hybrid restorative materials, *S. mutans*

INTRODUCTION

Dental caries is the most prevalent disease of mankind leading to early loss of teeth. The presence of micro-organisms in the oral cavity is one of the most important caries risk factors. Certain bacteria have been identified as more cariogenic than others among which the most important organism was *Streptococcus mutans* [1].

Early attempts to control caries, involved techniques which removed sound tooth structure along with pits and fissures and then restored with restorative materials which do not have antimicrobial activity. Recurrent caries are lesions at the margin of existing restorations that become carious [2]. Undesirable events such as pulp injury and pulp necrosis are frequently associated with the presence of residual bacteria after carious dentin removal and the ingress of new micro-organisms in the tooth-restoration interface as a result of micro leakage [2]. In these procedures, restorative cements with antimicrobial properties are used in direct contact with residual carious tissue to promote the rehardening of the tissue and to reduce the viability of residual bacteria, thus preventing the occurrence of secondary caries.

Besides antibacterial activity, such materials should also have good biocompatibility with the dentin-pulp complex [3]. In the past, various dental cements were evaluated for their antimicrobial properties and it was found that this property is due to their low pH and due to release of fluoride ions from them. However, there is insufficient data regarding the fluoride release and low pH of recently used dental cements for their antimicrobial effect [4,5].

Glass ionomer cements are said to have excellent tooth bonding properties and also antimicrobial property but they are sensitive to moisture contamination, have low initial mechanical properties and inferior translucency. Hence, recently hybrid materials combining the technologies of glass-ionomers and composites were developed to overcome the above disadvantages of glass-ionomer cements. These hybrid materials mainly include Resin-modified Glass ionomer cement's (RMGIC's), Compomers (Polyacid-modified composites) & Giomers [6].

As there is very little data regarding antimicrobial properties of hybrid restorative materials, this study was undertaken to evaluate the antimicrobial efficacy of three hybrid restorative materials viz., Fuji II LC (Resin-modified glass-ionomer), F2000 (compomer) and Beautifil (Giomer) against the *Streptococcus mutans*.

MATERIALS AND METHODS

This study was conducted at Dept. of Pedodontics with Preventive Dentistry, Govt. Dental College and Hospital, Hyderabad and Dept. of Microbiology, Institute of Preventive Medicine, Hyderabad in the year 2013.Three different light curing restorative materials, Giomer (Beautifil-II, Shofu Inc., Kyoto, Japan), F2000 (3M Dental Products, Hytac, ESPE) and Fuji II LC (GC Fuji II™ LC, GC Corporation, Tokyo) were used for the preparation of discs. A sterile hollow metal ring with 5mm inner diameter and 2mm thickness was used for the preparation of discs. Vaseline was applied as a separating media to the inner diameter of the ring. Beautifil and F2000 which are supplied in syringe form were flowed into the metal ring over a glass slab sandwiched between two mylar strips and light cured for 40 sec with halogen light curing unit and then removed from the ring to get the disc form. Fuji II LC is a powder-liquid system. Powder and liquid were mixed as per the manufacturer's instructions, placed into the ring and light cured for 40 seconds. All the specimens were sterilized by autoclaving at 121^{0}c at 15 lbs pressure for 15 min. Thus a total number of 30 discs (10 from each material) were prepared from three different restorative materials to test the antibacterial efficacy.

Standard strains of *Streptococcus mutans* (MTCC 497) in the form of lyophilized culture were obtained (Institute of Microbial Technology, IMTECH, Chandigarh) and used to test the antimicrobial efficacy of three different restorative materials.These microorganisms were grown in 5ml of Brain Heart infusion broth (Hi Media Laboratory Pvt. Ltd., Mumbai, India) for 24 hours at 37^{0}c to form an inoculum. The bacterial colonies were taken from the broth cultures and adjusted to 0.5 Mc Farland standard. Brain heart infusion agar was used for diffusion test. About 15ml of Brain heart infusion agar was spread evenly to a thickness of 5mm in petridish and after solidification, the agar plates were dried and three wells of 5mm diameter and 2mm depth were made in agar plate with agarpunchers. These wells were incorporated with material discs of same dimensions of three restorative materials.

About 100µl of bacterial inoculum was poured with micropipette over the agar plate and it was spread evenly using plate spreader to ensure even distribution of the bacterial inoculums. All the procedures were carried out under aseptic conditions in a laminar airflow chamber. Three different materials were tested in each plate at required distances from the edge of the plate and between each other and the plates were inverted and incubated aerobically for 24 hours at 37^{0}c under 5-10% CO_2.The diameter of the zones of inhibition in millimeters (mm) around the material discs were measured after 24 hours. The results were expressed as mean diameters and standard deviations.

STATISTICAL ANALYSIS

Data was analysed by one-way ANOVA (using software SPSS version 10.0) with LSD post-hoc test to compare the statistical difference of antibacterial effects in between three restorative materials tested with a bacterial strain (*Streptococcus mutans*).

RESULTS

The mean values and the standard deviations of the growth inhibition zones of three restorative materials are shown in [Table/Fig-1]. Inter-group comparisons in between three restorative materials by least square difference (LSD) post-hoc test are shown in [Table/Fig-2]. The post-hoc test indicated that the difference in inhibitory zones between Fuji II LC and Beautifil, Fuji II LC and F2000 showed significance ($p<0.05$), where as between Beautiful and F2000, the difference was not significant ($p> 0.05$).

Materials	Mean values of inhibition zones ± SD (in mm)	p-value
Fuji II LC	10.1 ± 1.97	p < 0.001***
Beautifil	8.20 ± 1.62	
F2000	6.90 ± 1.29	

[Table/Fig-1]: Mean values of inhibition zones in mm of three restorative materials against *S.mutans*
***:Highly Significant (p<0.001), SD-Standard Deviation

(I) Group	(J) Group	Mean diff (I – J) ± SD	p-value
Fuji II LC	Beautifil	1.9 ± 0.737	p<0.05**
	F2000	3.2 ± 0.737	p<0.05**
Beautifil	Fuji II LC	-1.9 ± 0.737	p<0.05**
	F2000	1.3 ± 0.737	p >0.05*
F2000	Fuji II LC	-8.2 ± 0.737	p<0.05**
	Beautifil	-1.3 ± 0.737	p>0.05*

[Table/Fig-2]: Inter groups comparison by least square difference (LSD)
**:Significant (p< 0.05), *:Not significant (p> 0.05), SD-Standard Deviation

DISCUSSION

As of today, recurrent caries is one of the serious problem which decreases the longevity of a restoration and when left untreated it leads to various invasive procedures which are expensive and also unpleasant for the patient [7]. Hence, restorative materials with antimicrobial properties will help the teeth from recurrent caries. After the invention of glass-ionomer cements, there is decrease in recurrent caries due to its antimicrobial property which is attributed to release of fluoride ions. These ions also help in remineralization of initial caries lesions and also hamper the progression of dental caries [8].

Glass-ionomer cements are also able to inhibit the invitro growth of some oral bacterial species because of their initial low pH [9,10]. The same antibacterial inhibitory effect has been demonstrated for a new generation of materials like resin-modified glass ionomer cements, compomers and giomers. Each of the hybrid restorative materials in this study tended to have antimicrobial effect against *S.mutans*. The same results were found in studies conducted by Shivani et al., and Kavita Hotwani et al., where hybrid cements reduced the number of *S.mutans* invitro [11,12].

The difference in antibacterial activity in between the three restorative materials is due to the varying amount of fluoride present in them, nature of the fluoridated glass incorporated into each material and the extent to which a glass-ionomer matrix layer surrounds the glass filler in the set material.

In our study the difference between resin-modified glass ionomer & poly-acid modified composite during the first phase of fluoride release could be due to the fact that after curing and before contact with water the fluoride in poly-acid modified composites is not free but bound in the filler particles which are enclosed in the polymerized matrix. It should be noted that in the first phase of setting, which is a light-activated polymerization, poly-acid modified composites completely behave like composites. Also, in poly acid-modified composite the fluoride release is altered as a result of more tightly bound and/or less hydrophilic matrix of the composite resin [13].

The main filler fraction in compomers and composites does differ significantly. When in composites rather inert Barium-glasses or alike are typically used, the filler glass in a typical compomer is identical to that of glass-ionomers. Additionally strontium fluoride or ytterbium trifluoride is added for radio-opacity and may increase fluoride release too. With regard to compomers, Annette Wiegand et al found that fluoride release is higher in compomers containing glass fillers and ytterbium trifluoride when compared to compomer with strontium fluoride [14].

On the other hand, compomer (F2000), containing strontium-fluoro-silicate glass filler, a thin layer at glass-ionomer matrix is formed in the surfaces of the glass particles by reaction of the glass with acid which is present in the resin matrix. Giomer (Beautifil) also contains fluoridated glass filler with a glass-ionomer matrix layer, but this glass filler has a significantly thicker hydrogel layer which has been made by partial reaction with acid to form a sub structural glass-ionomer matrix layer before incorporation in the resin matrix. This glass ionomer matrix contains much complex fluoride and is easily penetrated by water resulting in a significantly greater fluoride release from this material. Hence, it is likely that the extent of the hydrogel matrix of the glass filler incorporated into the materials affected the amount of fluoride released at the initial period.

Giomers were in second place in inhibiting *Streptococcus mutans* after resin-modified glass ionomer cements. This is because giomers behave more like resin-modified glass ionomers and has a cumulative fluoride release of about 20% of the original GIC. This decrease might be partially attributed to the presence of silane coupling in the pre-reacted fillers versus non-silanized glass particles in the original GIC [15,16].

The Resin-modified glass ionomers showed better results when compared to compomers and giomers, this is in agreement with study conducted by Saketh Rama Rao B et al., [17]. The reason behind this is, due to the inclusion of fluorite as fluxes for firing purposes in the RMGIC will enhance the release of fluoride ions into the matrix during the setting reaction in the initial 24 hour period and also the liquid component of RMGIC which contains hydroxyl-ethyl methacrylate may aid the antibacterial effect by providing a low pH.

RMGIC have better mechanical properties due to the incorporation of hydrophilic resin monomers, 2-hydroxy-ethyl dimethacrylate (HEMA) and also have better adhesion to dentin without losing the benefits of conventional glass-ionomer cements, such as fluoride release [18,19]. The fluoride release from resin-modified glass-ionomers is high, immediately after hardening of the restoration (within 24 hours) due to initial fluoride burst effect, followed by constant slow release of fluoride for weeks [20]. Duque et al., [21] also studied the antimicrobial activity of glass ionomer cement, resin modified glass ionomer cement and Fuji IX against *S.mutrans*, *S.sobrinus*, *L.acidophillus* and *A. viscosus*. They found that glass ionomer cement and resin modified glass ionomer cement presented the best antimicrobial activity against *S.mutans* and *S.sobrinus*. Similar results were found with study done by Yap AU et al., [22] in which initial fluoride burst effect was observed with conventional glass ionomer cement and resin modified glass ionomer cement. Compomer and giomer did not show initial burst effect.

CONCLUSION

As the Resin modified GIC was found to have superior antibacterial activity against *S.mutans* when compared with Giomer and Compomer, in deep carious lesions of primary and young permanent teeth, where complete caries removal is not possible due to the danger of nearing the pulp and also due to lack of cooperation in some children, it is better to go for restoration with RMGIC which has good antimicrobial property. This will help in reducing the residual bacteria in remaining carious lesion thus arresting secondary caries. But based on the invitro evaluation of antimicrobial activity with isolated bacteria, it is difficult to obtain a clear conclusion because the oral cavity contains a variety of micro-organisms and the effect of tested restorative materials against a single bacterial strain may not be effective against a mixed oral flora and also interaction of restorative materials with artificial media, the effects of which on microbial growth is unknown.

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