Antibacterial Activity of Glass Ionomer Cements on Cariogenic Bacteria – An in vitro study

Gabriela Lacet Silva Ferreira, Irlan de Almeida Freires, Lívia Araújo Alves, Vanessa de Carvalho Jovito, Fabíola Galbiatti de Carvalho, Ricardo Dias de Castro

Abstract

Background: Antimicrobial activity of restorative materials had an important role in preventing caries recurrence. Aims and Objectives: To evaluate the in vitro antibacterial effect of Glass Ionomer Cements (GIC) against Streptococcus mutans, S. oralis, S. salivarius and Streptococcus sp. Materials and Methods: Three commercially available glass ionomer cements, i.e., GIC1, GIC2 and GIC3 were evaluated. The products were manipulated in accordance with manufacturer’s guidelines and inserted into wells made-up in Petri plates containing Müller Hinton Agar. The antibacterial activity was evaluated by using a caliper to measure the diameter of halos of growth inhibition of the strains assayed. The study was performed in triplicate and statistical analysis employed Kruskal-Wallis test (α=5%). Results: GIC1 showed halos of growth inhibition in millimeters of 16±2.0, 16±0.0, 11±1.0 and 13±2.0 on S. mutans, S. oralis, S. salivarius and Streptococcus sp respectively. On those same strains, GIC 2 presented halos of 22±0.0, 18±0.0, 19.6±2.4 and 24±0.0 millimeters and GIC 3 showed 17.3±1.3, 16±0.0, 13±1.0 and 22±0.0 millimeters halos of respectively. Statistical analysis indicated a significant difference for antibacterial activity between GIC 1 and GIC 2 (p<.05) on all strains. Conclusion: All three GIC’s under evaluation, promoted growth inhibition of the cariogenic bacteria assayed. Key Words: Glass Ionomer Cements; Anti-bacterial agents; Streptococci

Introduction

Acidogenic bacteria play the main role in the development of dental caries (1, 2). In an attempt to obtain restorative materials that could prevent marginal gaps colonization, materials capable of releasing fluoride and providing antimicrobial activity have been developed, such as, Glass Ionomer cements (GIC), “compomers” and fluoridated composite resins (3, 4). Glass Ionomer Cement is a biocompatible material, and it promotes both inhibition of demineralization and additional remineralization of tooth structures adjacent to fillings, as well as interferes with bacterial growth, stabilizing the microbiota despite the presence of fermentable carbohydrates (5).

GIC’s fluoride releasing property has been documented in the literature. (6-8). After being released from GIC, the fluoride ions take part in the de- and remineralization phenomena, and may act directly on the carious process. (3, 9) There are divergences regarding the antimicrobial activity of restorative materials since researches have been found to show both positive and unsatisfactory outcomes (10). In this elucidative perspective, the present paper evaluates the in vitro antibacterial activity of Glass Ionomer Cements (GIC) on Streptococcus mutans, S. oralis, S. salivarius and Streptococcus sp.

Materials and Methods

The study was conducted using an inductive approach, statistical-comparative procedure and intensive direct documentation technique in laboratory. Antibacterial assays were performed at the Oral Microbiology Laboratory, Center for Tropical Medicine, Center for Health Sciences, Federal University of Paraíba. Indications and compositions of the GIC under evaluation were condensed in Table 1. Three commercially available glass ionomer cements, i.e., GIC1, GIC2 and GIC3 were evaluated. The products were manipulated in accordance with manufacturer’s guidelines and inserted into wells made-up in Petri plates containing Müller Hinton Agar. The antibacterial activity was evaluated by using a caliper to measure the diameter of halos of growth inhibition of the strains assayed.

Microorganisms: Bacterial strains, provided by Oswaldo Cruz Foundation (Rio de Janeiro, Brazil), were reactivated in Brain Heart Infusion culture medium (HIMDEIA®, Sao Paulo, Brazil). After a 24h incubation period in bacteriological incubator at 37°C, 100 μL of the strains inoculum were plated out by using disposable straps on blood agar culture medium (Müller Hinton agar, DIFCO®, Sao Paulo, Brazil, plus 5% blood).

Antibacterial Activity Assessment: GIC antibacterial activity was determined through diffusion method on solid medium. Three 6.0mm-diameter wells were made-up in each plate by using sterile disposable tips. The glass ionomer cements were manipulated on a sterile glass board
in accordance with manufacturers’ guidelines and then inserted into each well until its complete filling, by using the Centrix® system (DFL®, Rio de Janeiro, Brazil). The plates were incubated at 37°C in bacteriological incubator for 48 hours and the reading of results was done afterwards. Tests were performed in triplicate.

Statistical Analysis: The diameter of growth inhibition zone was measured in millimeters through a caliper. Data gathered were statistically treated by the software GraphPad Prism 5.0. Kruskal-Wallis and Dunn’s post-test for multiple comparisons were employed, and confidence interval was set at 95%

Results

It has been found that all Glass Ionomer Cements under evaluation have antibacterial properties against S. mutans, S. oralis, S. salivarius and Streptococcus sp. GIC 2 has showed the longest diameters of halos of growth inhibition against all strains. GIC 1, on the other hand, has presented the shortest zones of bacterial growth inhibition, probably resulting of a lesser antibacterial power. Given this, there was a significant difference for antibacterial activity between GIC 2 and GIC 1 (p<.05) on all strains. Table 2 brings means and standard deviations of the values obtained by the GIC antibacterial activity assessment.

Discussion

Studies previously conducted have verified bacterial growth inhibition promoted by both conventional and modified GIC.(11, 12) In spite of that, it is important to consider that many of those studies have found differences with regard to GIC antibacterial effects according to the strain assayed.(13, 14)

The present study findings differ from those obtained by Lima et al., in which GIC 1 showed no potential in inhibiting S. oralis growth. Nevertheless, similar results could be found when the above cited GIC was assessed against S. salivarius, with mean diameter of inhibition zones reaching 11mm.(15)

An in vitro study tested the antibacterial effect of the following glass ionomer cements: Ketac-Fil, Ketac-Silver, Fuji II LC and Vitremer on Streptococcus spp, Lactobacillus spp, Actinomyces spp, Porphyromonas spp, and Clostridium spp by diffusion method in solid medium.(12) The present investigation has equally encompassed cariogenic bacteria and the same antibacterial assessment method. All four GIC studied by Herrera et al. presented positive outcomes, although some notable differences have been observed among them.(6) Vitremer was the material which showed the best results, whereas Ketac-Silver had the lowest inhibitory activity.

Differently, only resin-modified glass ionomer cements, Vitremer and Vitrebond, were found to present effective bacterial inhibition.(6) Vidrion R, conventional glass Ionomer cement, was the only material to demonstrate in vitro antibacterial effects from a list of nine restorative materials tested against S. mutans, Micrococcus luteus, Staphylococcus aureus and S. sobrinus. However, when GIC components (powder and liquid) were evaluated alone there was a halo of growth inhibition around the liquid in all materials, whereas powder by itself presented no antimicrobial activity.(2)

The different antibacterial properties of glass Ionomer cements might be related both to varied compositions existent in these materials (presence or absence of oxides, type of acids present in the composition) and to fluoride-releasing property. An in vivo study performed to evaluate the effect of atraumatic restorative treatment (ART) on remaining demineralized dentin has found that in three months after GIC fillings being made in sample cavities there was great reduction in the amount of bacteria as well as increased density of intertubular dentin, and higher proximity of collagen fibers. This result reinforces
ART indication and the advantages of glass ionomer cements. According to several investigations, the ability to inhibit bacterial growth is attributed to fluoride release in the oral environment and low pH of these materials after handling. Methodologically, it is emphasized that this study indicates GIC antibacterial activity on species involved with oral cavity infectious processes, especially tooth decay.

The assessment method employed here gives a general idea on the antimicrobial effects promoted by experimental products. Nonetheless, it contains some limitations, including lipid solubility-dependent diffusion through culture medium, thus depending on the product composition. Based upon that, other tests determining antibacterial activity of the components alone are necessary.

**Conclusion**

All Glass Ionomer Cements assessed have proven antibacterial activity against *S. mutans*, *S. oralis*, *S. salivarius* and *Streptococcus* sp. Additionally, GIC 2 has presented antibacterial activity equivalent to GIC 3 and stronger than GIC1. Despite these findings, more sensitive and more specific trials are required to determine the materials’ constituents responsible for that said antibacterial effect. Further studies are suggested to be undertaken covering other materials and a larger number of cariogenic bacteria.

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**Authors Affiliations:**

1. Dr. Gabriela Lacet Silva Ferreira, 2. Dr. Irlan de Almeida Freires, 3. Dr. Lívia Araújo Alves, 4. Dr. Vanessa de Carvalho Jovito DDS, Federal University of Paraiba, Joao Pessoa, 5. Dr. Fabiola Galiatti de Carvalho, DDS, MSc, PhD, Assistant Professor, Federal University of Campina Grande, Campina Grande, 6. Dr. Ricardo Dias de Castro, DDS, MSc, PhD, Adjunct Professor, Department Social Dentistry, School of Dentistry, Federal University of Paraiba, Joao Pessoa, Brazil.

**References**


**Address for Correspondence**

Dr. Gabriela Lacet Silva Ferreira, Department of Clinics and Social Dentistry, School of Dentistry, Federal University of Paraiba, Joao Pessoa, Paraiba, Brazil.

Ph: + 55 83 3245-2540

E-mail: gabrielalacet@yahoo.com.br

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