Evolution of Modified Glass Ionomer Cements: A Review

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Abstract

Glass ionomer cement has been the subject of extensive research over the last few decades. Refinements were made to the composition of GICs in an attempt to formulate an ideal restorative material (RM) having strength, adherence, natural appearance, and anticariogenicity. Contrary to early glass ionomers, the new restorative systems are easy and practical to use. The emergence of GIC as a 'material of choice' for various applications in dentistry is mainly due to its fluoride-releasing and chemical bonding properties. This article throws light on the evolution and the course of recent advancements of Glass ionomer cement.

Keywords: *Restorative material, glass ionomer, cement.*

Introduction

"Necessity is the mother of invention". There has been a never-ending need to upgrade and advance materials and techniques in dentistry due to changing professional perceptions and to meet the patient's demands. Currently, the patients demand higher aesthetic and biocompatible restorations at lower costs. In this day and age restorative dentistry is switching from metallic to non-metallic materials.[1]

Back in the 1960s, there was an availability of a variety of restorative materials including amalgam, composite, cast alloys etc, but none of them could be categorized under ideal restorative materials. An ideal restorative material is the one that is aesthetic, biocompatible, adhesive, anticarcinogenic and relatively economical.[2] Researchers then began their experiments to create a material that would not only act as a restorative but also replace enamel and dentin.[3] This led to the advent of Glass ionomer cementin 1969 as reported by Wilson and Kent in 1970s.[4]

Materials made of calcium or strontium aluminofluorosilicate glass powder (base) combined with a water-soluble polymer (acid) are the glass polyalkenoates.[4] With Kent calling such materials "glass ionomer" cements the name has become part of the dental jargon. The advantages of glass ionomer cement include adhesion, good marginal seal, fluoride release and biocompatibility but it had a disappointing clinical performance in primary molars as they are sensitive to dehydration early in the setting process and are brittle materials making them unsuitable for use in stress-bearing areas which is why attempts have been made to enhance properties of the glass ionomer cement by modifying the chemical composition of the original powder.[5,6]

History of GIC'S: What began with a small group of dentists and researchers in Londonin 1950s researching to produce a new RM that has similar properties of enamel and dentin and went through a long list of attempts at modifying silicate cement and other modifications are still undergoing attempts for a better one.[7,8]

The first zinc polyalkenoate cement by Smith in 1968 resulted in the introduction of the first adhesive

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RM for dental purposes. The contemporaries Wilson and his group decided to use the polyalkenes acid as a liquid for silicate cement powder.[3]

The first GIC had strength and fluoride release property from silicate glass and biocompatibility and adhesion from polyacrylic acid liquid turned out to be a hybrid cement consisting of calcium fluoroaluminosilicate glass powder and polyacrylic and itaconic acid liquid.[9]

This class of material has achieved widespread use as translucent materials for restoration, fast setting liners and bases, for binding composite to the tooth structure, fine grain luting cement, fissure sealants and metal reinforced core build-up materials.[10,11]

Over the last few decades,compositional changes to both powder and liquid components, as well as clinical experience, has highlighted the practical advantages and disadvantages of GIC.[12]

Modifications of GIC:

Resin Modified Glass Ionomer: Small quantities of light-polymerizable resin groups (usually 2-hydroxyethyl methacrylate or HEMA) into the acidic liquid component was added to modify conventional GIC's physical properties and translucency.[13]

Metal Reinforced Glass Ionomers: Addition of amalgam alloy powder and sintered silver particles to the glass component to form a "Cermet" (ceramic-metal). Evidence of significant improvement in the physical properties of GICement was seen. Further research on this material witnessed diminished caries resistance compared to conventional glass ionomers.[13]

High-Viscosity Autocare Glass Ionomers: High viscosity GIC was introduced to have a strong and adhesive restoration with fluoride releasing propertiesto treat in remote undeveloped regions lacking access to dental care.[13, 14]

Polyacid Modified Composite Resins (Compomers): The term "Compomer" strikesas an intent to combine components and favorable properties of both GIC and composite. They possess the aesthetics of composites and fluoride-releasing trait of GIC though the fluoride release compared to the conventional GIC was negligibleas there was no fluoride uptake by the cavity walls due to the resin bonding agent acting as a barrier.[13]

Zirconia Reinforced GIC: Zirconia infused glass ionomer cement (ZIRCONOMER) is a recent addition to the GIC family which has been introduced to address all the issues that have plagued the conventional ionomer till now. The combination of Hydroxyapatite and zirconia (HAp/ZrO_2) at 4% volume concentration to the GIC powder refined the mechanicalattributes.[15]

Fibre-Reinforced GIC: Improved curing depth, wear-resistance, and flexural strength and reduced polymerization were observed when alumina fibres were mixed with glass powder. This polymeric rigid inorganic matrix technology involves the incorporation of a continuous network/scaffold of alumina and silicon dioxide ceramic fibres.[16]

Proline-Containing GIC: An amino acid–containing GI cement with better surface hardness, quick setting,and increased water sorption properties without adversely affecting the amount of fluoride release. Due to low cytotoxicity and good biocompatibility, it was also considered to use as a bone cement.[16]

Calcium Aluminate GIC: Properties of this GIC show a mix of calcium aluminate and luting GIC. Advantages include pH greater than 7 during curing, reduction in marginal leakage, improved biocompatibility, and greater stability and strength.[16]

Powder-Modified Nano Glass Ionomers: Described by De Caluwé et al, the mix of conventional glass ionomerwith nano-sized glass particleslike nano-apatite and nano-fluorapatite decreased setting time and enhanced compressive strength and elastic modulus after being stored in distilled water for 7 days.[18]

Nano-Filled Resin-Modified GIC: Incorporation ofnano-sized fillers and bioceramic particles to RMGICswas done to improve mechanical properties.[19,20] Increased ionic bonding with a tooth was observed instead of micromechanical bonding.[18]

Chlorhexidine Impregnated GIC: Approximately 10 ppm of fluoride release by GIC was observed during the 1st 48 hrs following its placement in the prepared cavity.To improve the antibacterial characteristics Chlorhexidinedigluconate can be added to it.[21]

Conclusion

Glass ionomers have been a mainstay of restorative dentistry due to its unique advantages. With time various modifications of this cement have been introduced

with added advantages and manageable disadvantages. Though the quest for newer materials gave us some great restorative systems, one still cannot replace GIC completely in restorative dentistry due to its advantages such as biocompatibility, fluoride release, and its workability in the moist environment.

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