REVIEW ARTICLE

GLASS IONOMER CEMENT-A PHOENIX AND ITS NEW FLIGHT

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ABSTRACT:
Glass inomer cement a versatile material in dentistry, used ever since 18711.But its use resurged recently as a smart material. A material with two basic types ,the older, self hardening cement which sets by an acid base neutralization reaction to give a relatively fragile material, and the latest modified material which sets partly by polymerisation and partly by neutralization. The latter material has improved esthetics, resistance to moisture and greater toughness. Recent studies have evaluated various combinations in glass ionomer structure, which will enhance the biocompatability, strength; regeneration capacity of Glass Ionomer Cement2.This paper is an attempt to review the future prospects of GIC.
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INTRODUCTION

The quest for discovery of an ideal material to replace natural tooth substance continues to be an elusive goal[3]thus ***"Necessity is the mother of invention".*** Numerous materials have been introduced in dentistry, over the years which claim to have nearly ideal properties as a restorative material. However, it has been found that although one given material may have numerous attributes, it will be lacking in some desirable properties. A prominent example as such is Glass ionomer cement. History had already witnessed a host of restorative materials including amalgam, composite, cast alloys etc.

But all were short of that perfection that clinicians yearned, a material that would be esthetic, adhesive, biocompatible, anti-cariogenic and relatively economical. It was during this time that Glass Ionomer Cement came as a breakthrough, and created quite a sensation, by not only possessing a majority of these desirable properties, but also providing a wide scope of modification and improvements. The aim of this article is to revise the most recent advancements of GIC and to evaluate its new potential in the coming future similar to the Phoenix which rises from its own ashes and swears high for a new flight.

HISTORY AND DEVELOPMENT

In 1873, Thomas Fletcher of United Kingdom developed silicate cements, as an anterior restorative material, which was translucent and released fluoride, but was weak, not adhesive. This was followed by a combination of similar glasses and poly acids to produce GIC in 1972 by Wilson & Kent [4] (also known as Glass Polyalkenoate Cement[5] ISO 7489:86). Jurecic in 1973 found that gelation of concentrated polyacrylic acid solution on standing due to intra change hydrogen bonding, could be avoided by the use of acrylic acid itaconic acid copolymers. The use of this principle allowed GIC to be used as a restorative material. Many years passed by before a clinically acceptable GIC was commercially produced, although GIC was first patented in 1969, it was in 1974 that the first commercial brand DeTray ASPA was available. Since then commercial companies have made significant improvements to basic GIC formulations.

Developments and increasing endorsements of clinical advantages like long term adhesion and persistent fluoride release, biocompatibility, esthetics and toughness has led to its greater acceptance.

COMPOSITION

Glass ionomer cement is a combination of "Glass" powder and "Ionomer" acid. Basically an acid soluble calcium alumino silicate glass containing fluoride, it is formed by fusing silica, alumina, calcium fluoride, metal oxides and phosphates at 1100-1500° C & then pouring the melt into water[6].The glass formed is crushed, milled and ground to form powder of 20-50µm size depending on what it's going to be used for. Alumina (Al_20_3) increases opacity, Silica ($Si0_2$) increases translucency. Fluoride performs various functions like reduction in fusion temperature, increases translucency, anticariogenicity, increases strength and working time. Calcium Fluoride (CaF_2) acts a flux and increases opacity. Aluminium phosphate decreases melting temperature. Al203:SiO_2 ratio is crucial & should be greater than 1:2 for cement formation to occur. Cement formation will occur only when there will be sufficient replacement of Si by Al to render the network susceptible to avoid attack. This basic composition has been modified for the new development of GIC. Glass can be modified by several ways to enhance the physical properties of the cement:

- Ca can be replaced by by Sr, Ba or La to give a radio-opaque glass.
- Corundum, Rutile disperse phases can be added to increase flexural strength.
- Metals, resins, fibers are added to increase the strength.

ADVANCEMENTS IN GIC

1.BAG (Bioactive glass): First Bioglass was invented by Larry Hench[7] and colleagues at the University of Florida first ,and later developed by his team in late 60s.Because of good bioavailability, osteo-conductivity and biodegradability BAG has been used in clinic for more than a decade as a bone repair material. In the last decade,BAG showed that the degradation products of BAG could stimulate the production of growth factors, cell proliferation and activate the gene expression of osteoblast, also helps in treating dentine hypersensitivity and promoting enamel remineralisation. The only one material which could bond to hard and soft tissue.[8]Concerning the mechanism of apatite formation on the surface of bioactive glass, it has been proposed[9] that hydrated silica developed on their surfaces in the body includes nucleation of the apatite. Hence, it was confirmed that pure silica gel prepared by hydrolysis and poly condensation of tetraethoxysilane in aqueous solution containing polyethylene glycol induces the formation of the apatite layer on its surface, when the gel is leaked in stimulated body fluid. A material is said to be bioactive, if it gives an appropriate biological response and results in the formation of a bond between material and tissue. In addition to remineralisation[10]

BAG has antibacterial effects as they can raise the ph of aqueous solutions. Combination of bioactive nano silica with dental cement improves its biocompatability, which may be helpful to overcome marginal gap formation which is a major disadvantage of the commercial dental cement.

2. **ACP**: It is the initial solid phase that precipitates from a highly supersaturated calcium phosphate solution and can convert readily to stable crystalline phases such as osteocalcium phosphate. Morphologically, structurally and X ray diffraction patterns are typical for non crystalline substances with short range periodic regularity.ACP has shown to have better in vivo osteo-conductivity than hydroxyapatite, better biodegradability[11] than tri-calcium phosphate. These properties make ACP widely used in dentistry. It was first developed by Aaron S Posener[12] in mid 1960's. In conjunction with CPP it is creating wonders in GIC and dentistry.

3. **Casein Phosphopeptide Amorphous Calcium Phosphate Complex (CPP-ACP)**. It is a milk product which helps in remineralisation and prevents dental caries.CPP decreases the count of Streptococcus mutans and is a peptide which has elements that can bind with calcium and also bind with ACP to bind with dental enamel.CPP forms nanoclusters with ACP and makes a pool of Ca and phosphate which maintains the super saturation of saliva. Mazzoui et al in 2003, used CPP ACP with fluoride and demonstrated a synergistic remineralisation potential[13]. It can be delivered using tooth mousse, chewing gums, rinses, toothpastes

[14]and GIC. It has the ability to counteract acid action[15].These products have imparted a new direction to preventive dentistry and its incorporation in GIC is a new sensation.

4. **Reinforced GIC:** Recently scientists have come up with the idea of introducing nano particles such as TiO_2, nano tubes, nano fluroapatites into GIC matrix to enhance their mechanical strength. This allows a highly packing dentistry of mixed particles within the GIC matrix. An acid base reaction takes place during the setting procedure, which forms a salt hydrogel, acting as a bonding element in matrix within which glass acts as a reinforcing[17] role. Thus, Al_20_3 and TiO_2 nano powders can be employed to manufacture advanced GIC.

5.**Chlorhexidine impregnated GIC:** High viscosity GIC is the material of choice for atraumatic restorative dentistry techniques, since GIC adheres chemically to dental structure and releases fluoride, which contributes to reduction in amount of residual bacteria[18] in restored cavities but also favors in remineralisation.GIC releases approximately 10 ppm of fluoride during the 1st 48 hrs following insertion in the cavity[19].In order to improve the antibacterial characteristics Chlorhexidine [20]digluconate has been added to it[21].It is still under wraps of experiments and soon will be bubbling out for a new flight in dentistry.

6. **Zirconomer:** It defines a new class of restorative GIC, which promises the strength and durability of amalgam, plus the protective and esthetic benefits of GIC, while completely eliminating mercury hazards. It is developed to exhibit stength of amalgam so also called white amalgam. The inclusion of zirconia fillers in the glass component of zirconomer[22] reinforces the structural integrity of the restoration & imparts higher mechanical properties for the restoration of posterior teeth.The glass component of this high strength glass ionomer undergoes finely controlled micronisation to achieve optimum particle size and characteristics. The polyalkenoic acid and other components have been specially processed to impart superior strength. Easy mixing and adequate working time enhances its utilization as a future material. Combination of outstanding strength, durability and sustained fluoride protection, deems it ideal for restoration in posterior teeth in patients with high caries incidence.

7. **Ceramir and Biomer:** Ceramir is the latest venture of developing GIC's .It is a water based hybrid combination, composed of Calcium Aluminate & GIC components mixed with distilled water. It is used as a luting agent whereas Biomer is used as restorative cement.

8. **Strontium oxide added GIC:** Strontium is a cement forming ion and it slows down the setting reaction at both 21°&37°Centigrade thus imparting more radiopacity as compared to calcium aluminate added glass ionomer.

CONCLUSION:

Glass inomer cement has undergone significant improvements. In general, GIC have become a topic of interest about their unique properties. By the incorporation of latest hydroxyapatatite and metallic nanofillers, it can serve as an ideal material with better properties. However still research is required for its future horizons.

REFERENCES:

1. Graham J Mount, An atlas of glass ionomer cement ,March-May 2011.
2.Tr Mahesh singh,J.sandhyarani vol 1,issue 1,march may 2011.
3.Muner ,Gohar babar ,S,M,Farooq,jPDA,vol-11,No 2 april-june 2002.
4.Wilson ,Ad kent BE,mclean J.W.,GIC,Chicago,Publishing co,1988;14
5.Teruka c &karasawa y setting solution for GiC patent number 409830
6.graham j mount ,an atlas of gic.
7.LL hench,R.j Splinter W.C.Allen T.K.grenule.J Biomed mater res (1971)117-141.
8.L L Hench ,i d XYMOR j . m.Polak,birmat sui polym,ed(15)2004,543-562.
9.P .li,c othswki,T.kokubo,j am ceram,soc 75(1992-2094)
9.Hench,wilson J an introduction bioceramics,singapore,world scientific publishing 1993.
10.World journal of dentistry,april june 2012,3(2)199-201.
11.zaho et al,ACP & its application in dentistry,Doi 10.1180/1752-153,540.chemistry central journal 2011.5.40.
12.Boskey AL ACP,the contention of bone,J.Dent 1997,76:1433-1436.
13.Mazzoui et al,incorporation of CPP ACP into GIc,j dent res 2003,82,914-8.
14.Nairim wilson,minimally invasive

dentistry,management of dental caries,1st edition 2007,p 69-70.
15.Piekar c,rajnikanth s,an in vitro assessment of rolr of tooth mousse in preventing wine erosion.aust dent j,2008,53(march 1)22-5.
16.Gu,y.w.A.U.,J,P cheang,2005.effects of incorporation of HA/ZRo2 into GIC,Biomaterials,26;713-720.
17.J basic applied sci,Rus 2(8)7526-7529,2012.
18.Mazzaoui SA,burrow mf,floride release from gic &resin composites dent mater 2006;16,166-71.
19.Mazzsara ml,art clinical ultrasound caries res 2002,36,436.
20.Brazillian dental journal 2014,25(1)33-37,http//dx.doi.org/10;1590/0103.
21.Takkash y,imazato ,tay f r,antibacterial effects and physical ppts of gic containing CHX for ART approach.Dent mater 2006,22,647-652.
22.www.shofu.co.jp.shofu.inc.11.
23.Advancements in gic cement. Journal of minimal intervention in dentistry by carel l davidson.

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