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Advances in Glass Ionomer Cement (GIC): A Review

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Abstract: *Glass Ionomer Cements have their origin in the middle of twentieth century, when a peculiar demand for a biocompatible, cost effective materialbecame evident. Considering their unique ability to bond to the tooth structure coupled with fluoride releasing potential, GIC's have graduallyemerged as material of choice for a diverse yet distinctly typical procedures ranging from restoration to rehabilitation.Glass ionomers are applicable to many restorative situations,both as stand alone restoratives and in conjunction with composite resin.Although glass ionomer cement use as a restorative material, it has some drawbacks.This article reviews about the recent advances and their properties, advantages,disadvantages, indication and contraindication. An understanding of advances is essential for the optimal incorporation of these materials into common restorative procedures.*

Keywords: *Glass ionomer cement, Advances in GIC*

I. Introduction:

Man is never satisfied with discovery alone. He tries to improvise, experiment and modify his discovery in an attempt to surpass the original. Today's dentistry can be characterized by a move awayfrom metal towards non-metal restorations. Motivation ismainly based on concern for esthetics and biocompatibility. Such was the case with the GIC as well. In dentistry adhesion of restorative materials to tooth substance is an important objective.It is believed that a restorative should resemblethe tooth in all respects. It should possessidentical properties and would adhere tenaciously to the surrounding enamel and dentin. The glass ionomer cements are one ofthe products developed in this direction.Innumerable changes and inclusions were made in its properties and composition to overcome its inherent drawbacks such as lack of strength, early moisture sensitivity and inadequate esthetics.

Various modifications in Glass Ionomer cements were done. This article is an attempt to overview different advances in Glass Ionomer like Compomers, condensable/ self hardening GIC, low viscosity / Flowable GIC, Fibre Reinforced GIC, Giomers, Amalgomers, Hainomers, Chlorhexidine impregnated GIC, Proline containing GIC, CPP-ACP containing GIC, Zirconia containing GIC, Nano Bioceramic Modified GIC , Calcium aluminate GIC.

Compomers:

Definition: Compomer can be defined as a material that contains both the essential components of GIC but at levels insufficient to promote the acid –base curing reaction in the dark .Compomer is a combination of the word 'comp' for composite "omer" for ionomer. Though introduced a type of GIC, it became apparent that terms in of clinical use and performance it is best considered as a composite

Properties:

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- ADHESION: to tooth requires acid –etching as acid base reaction for ion exchange which requires water does not occur for some time after placement. Bond strengths achieved usually approach the typical resin bonding systems. It is = 18-24Mpa
- FLUORIDE RELEASE: is limited. It is significantly less than Type II or RMGIC. F release usually starts after about 2-3 months; it peaks initially and then falls rapidly
- PHYSICAL PROPERTIES: fracture toughness, flexural strength and wear resistance are better than GIC but less than composite.

Contraindications

Class IV lesions,Conventional class II cavities,Lost cusp areas,Restorations involving large labial surface

Advantages

Has Superior working characteristics to RMGIC, Ease of use, Easily adapts to the toothand Good esthetics

Recently, a 2 component compomer is being marketed as a P: L system or 2 paste system meant exclusively for luting. These are self adhesive due to the presence of water which starts off the acid base reaction. The powder contains the glasses, fluoride & chemical / light initiators .liquid contains the monomers, Poly acrylic acid, water and activators. These set via light chemical polymer as well acid base reaction.

Condensable / Self Hardening GIC -

These are basically, purely chemically activated RMGIC with no light activation at all.Developed mainly for luting purposes, they contain monomers and chemical initiatiors such a the benzoyl peroxide and t-amines to allow self polymerization.It is used mainly in paediatric dentistry for cementation of stainless steel crowns,space maintainers, bands and brackets

Advantages over conventional GIC'sare Packable + Condensable, Easy placement , Non sticky, Rapid finishing can be carried out, Improved wear resistance and Solubility in oral fluids is very low

The Low Viscosity/Flowable GIC –

As lining, pit and fissure sealing , endodontic sealers , sealing of hypersensitive cervical areas and has increase flow.eg: Fuji lining LC, Fuji III and IV, Ketac – Endo.

1. Fluoride charged materials:

This is a 2 part material comprising of A restorative part andA charge part.The restorative part is used in the usual way. When the first burst of fluoride is expended, the material is given a fluoride charge using the second part

2. Low pH "Smart" Material

Developed to enable release fluoride when the oral pH is low. Aptly called "Smart" materials, the F release is episodic and not continuous which helps to prolong the therapeutic usefulness of the material

The Bioactive Glass

This idea was developed by Hench and co in 1973. It takes into account the fact that on acid dissolution of glass, there is formation of a layer rich in Ca and PO4 around the glass, such a glass can form intimate bioactive bonds with bone cells and get fully integrated with the bone.

It is being used experimentally asBone cement, Retrograde filling material, For perforation repair, Augmentation of alveolar ridges in edentulous ridges , implant cementation, Infra- bony pocket correction

Fiber Reinforced GIC

Incorporation of alumina fibres into the glass powder to improve upon its flexural strength.This technology called the Polymeric Rigid Inorganic Matrix Material It involves incorporation of a continuous network / scaffold of alumina and SiO_2 ceramic fibres It has increased depth of cure, reduced polymerization shrinkage improved wear resistance and increase in flexural strength.

Giomer

Giomer utilizes the hybridization of GIC and composite by using a unique technology called the pre-reacted glass ionomertechnology.Thefluoroaluminosilicate glass is reacted with polyalkenoic acid to yield a stable phase of GIC this pre reacted glass is then mixed with the resin.Depending on the amount of glass which is reacted, the PRG technology can be 2 types:

F- PRG = reaction of Full / entire glass

S- PRG = Surface of glass

Eg: Beautiful, Reactmer

Amalgomers

These are restoratives which are glass ionomer based but with the strength of amalgam. They also provide F^- release, natural adhesion to tooth structure, good compatibility and prevent shrinkage, creep, corrosion or thermal conductivity problems associated with other filling materials.They have been found to have exceptional wear characteristics, along with other advantages of GIC

Hainomers

These are newer bioactive materials developed by incorporating hydroxyapatite within glass ionomerpowder.These are mainly being used as bone cements in oral maxillofacial surgery and may a future role as retrograde filling material. They have a role in bonding directly to bone and affect its growth and developement

Chlorhexidine impregnated GIC

It is developed to increase the anticariogenic action of GIC.Still under experimental stage. Experiments conducted on cariogenic organisms

Proline Containing Glass Ionomer Cement

It is an amino acid-containing GIC had better surface hardness properties than commercial Fuji IX GIC. This formulation of fast-set glass ionomer showed increased water sorption without adversely affecting the amount of fluoride release.Considering its biocompatibility, this material shows promise not only as a dental restorative material but also as a bone cement with low cytotoxicity

CPP – ACP Containing GIC

Here casein phosphopeptide-amorphous calcium phosphate incorporated into a glass-ionomer cement. Incorporation of 1.56% w/w CPP-ACP into the GIC significantly increased microtensile bond strength (33%) and compressive strength (23%) and significantly enhanced the release of calcium, phosphate, and fluoride ions at neutral and acidic pH.

Zirconia Containing GIC

Zirconia containing GIC – A potential substitute for miracle mix.Thediametral tensile strength of zirconia containing GIC significantly Greater than that of Miracle mix due to better interfacial bonding Between the particles and matrix.

NANO Bioceramic Modified GIC

Nano hydroxyapaptite / fluorapatite particles added to FUJI II GC, The glass ionomer cements containing nanobioceramics are promising restorative dental materials with both improved mechanical properties and improved bond strength to dentin.Nanohydroxyapatite/fluoroapatite added cements exhibited higher compressive strength (177–179 MPa), higher diametral tensile strength (19–20 MPa) andhigher biaxial flexural strength (26–28 MPa) as compared with the control group (160 MPa in CS, 14 MPa in DTS and 18 MPa in biaxial flexural strength).

Calcium Aluminate GIC

A hybrid product with a composition between that of calcium aluminate and GIC, designed for luting fixed prosthesis.The calcium aluminate component is made by sintering a mixture of high-purity Al2O3 and CaO (approximately 1 : 1 molar ratio) to create monocalciumaluminate.The main ingredients in the powder of this hybrid cementare calcium aluminate, polyacrylic acid, tartaric acid,strontium-fluoro-alumino-glass, and strontium fluoride. The liquid component contains 99.6% water and 0.4% additivesfor controlling setting.The calcium aluminate contributesto a basic pH during curing, reduction in microleakage,excellent biocompatibility, and long-term stability andstrength.

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