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Recent Advances in Dental Cements - A Review

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ABSTRACT:

Aim: To write a scholastic review on the recent advances of dental cements.

Objective: To gather knowledge on recent advances in dental cements, and their application in dentistry.

Background: Dental cements are hard, brittle materials formed by mixing powder and liquid together. They are either water based or oil based or resin based cements. Dental cements are used for a variety of restorative and orthodontic applications, such as luting agents, pulp-protecting agents or cavity-lining material, as well as in other endodontic treatments, and surgical procedures. The first used dental cement was silicate cement in the 19th century, and dental cements have evolved with better compositions and better biocompatibility. This review will focus on the recent advances of dental cements.

KEYWORDS: Glass ionomer cement, composite, nanocomposite, RMGIC.

Introduction

In the early nineteenth century, dental decay was considered as gangrene of the tooth, which resulted in nothing short of dental extraction, this was followed by preventive and restorative concepts put forth by Dr GV Black. [1]. The main goal of any medical or a dental procedure is to provide relief to the ailing patient in the best possible way, whilst following the Hippocratic oath: "First, do no harm". [2]. As dentists, we are challenged to restore function while providing a highly aesthetic result. Following the 20th century multiple choices are being made available to provide the best treatment plausible for the patient which is aesthetically pleasing as well as functionally strong dental cements that have prolonged longevity and is biologically compatible with the surrounding natural tissue. [3]. Recently dentistry has taken a step away from metallic restorations to non-metallic restorations.
This can be mainly attributed to the concern for aesthetics and biocompatibility. [4]. The dawn of the 20th century paved the way for multiple improvements and refinements of the dental cements, each aesthetically and functionally superior to its predecessors. [5]. Over the past decade, newer materials and techniques have been developed to improve the dependability and predictability of dental material for dentists. Dental amalgam has always been used as a primary dental restorative material for the last 150 years, but recent researches and studies have shown the detrimental effects of mercury on the environment, in the present times patients and dentists prefer other restorative materials such as composite and glass ionomer cements for their aesthetic, functional and ease of treatment. [6]. This review is aimed at summarising the recent advances in dental cements.

Resin Modified Glass Ionomer Cement

In the year 1988, Antonucci et al., introduced the resin modified glass ionomer cement to overcome the disadvantages of conventional glass ionomer cement. Resin modified glass ionomer cements are made in combination of resins and glass ionomer cements.
It consists of dimethyl methacrylate monomer, HEMA is grafted in polyacrylic acid.[7]. The rate of fluoride release by RMGIs is similar to that of conventional GIC. However, release of fluoride depends on the storage environment as well as the formation of complex fluoride derivatives with their reaction with polyacrylic acid. The fluoride release from various RMGIs during the first 24 hr is maximum with 5-35 µg/cm2. [8].

Application and Advantages of RMGICs

RMGICs find their applications as liners and bases in restorations, as well as pit and fissure sealants and as luting materials in stainless steel crowns and appliances. It can also be used as repair material for damaged amalgam restorations. [9] The advantages that RMGIC holds over conventional GIC are

RMGICs have longer working time, and are water resistant, with superior shade matching when compared to conventional GIC. [10]

Compomers:

Definition: Compomer can be defined as a material that contains both the essential components of GIC and composite resin but at levels insufficient to promote the acid –base curing reaction even in the dark. [11] Compomer is a combination of the word, comp for composite and "omer" for ionomer. Though introduced as a type of GIC, it became apparent that terms in of clinical use and performance it is best considered as a composite. [12]

Properties: Compomers have lesser fluoride release than RMGIC. It has increased fracture resistance, toughness, wear resistance, fracture resistance, better than conventional GIC but lesser than composite.[13]

Indications for the use of Compomers: They can be used under composite restorations, as well as in core build up, and in class III lingual restorations. They are potential root canal fillers [14]

Contraindications: Class IV lesions, Conventional class II cavities, Lost cusp areas, Restorations involving large labial surface. [15]

Advantages: Compomers have Superior working characteristics to RMGIC, Ease of use, Easily adapts to the tooth and superior esthetics. [16]. 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 are set via light chemical polymers as well as acid base reactions. [17].

Condensable / Self Hardening GIC:
These are a type of RMGIC which are activated purely chemically and need no light activation. It was developed in 1990, for the purposes of luting. They contain monomers and chemical initiators such a the benzoyl peroxide and t- amines to allow self polymerization. [18] Condensable GIC finds its application mainly in paediatric dentistry for cementation of stainless steel crowns, space maintainers, bands and brackets. [19].

It has Advantages over conventional GIC's as it's easily packable and condensate and also has easy placement, as it is non sticky. Rapid finishing can be carried out. Improved wear resistance and the solubility in oral fluids is very low. [20].

The Bioactive Glass:
This idea was developed by Hench et al, in 1973. It is based on the fact that acid dissolves of glass, and forms 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. [21]. Its experimental uses include applications such as Bone cement and as a retrograde filling material. It is also being used as a perforation repair, in Augmentation of alveolar ridges in edentulous ridges , implant cementation, Infra- bony pocket correction. [22].

Fiber Reinforced GIC:
The flexural strength of glass ionomer cements was improved by the incorporation of alumina fibres. This method is called the Polymeric Rigid Inorganic Matrix Material. It is done by the incorporation of a continuous network or scaffolds of alumina and SiO2 ceramic fibres. They have reduced polymerisation shrinkage, improved wear resistance, greater flexural strength and increased depth of cure. [23]

Giomer:
By the employment of a technology called the pre reacted glass ionomer technology GIC and composites were hybridised into Giomers. The fluoroaluminosilicate glass reacts with polyalkenoic acid to yield a stable phase of GIC this is then mixed with the resin. Depending on the amount of glass which reacted, the PRG technology can be 2 types:
F- PRG = reaction of Full / entire glass
S- PRG = Surface of glass. [24]

Amalgomers:
Amalgomers are restorative material that are based on glass ionomer but possess the strength of amalgam. They also provide fluoride release and natural adhesion to tooth structure, good biocompatibility and prevent shrinkage, corrosion or thermal conductivity problems associated with o ther filling materials like amalgam. They have higher wear resistance as well as possess all the advantages of GIC. [25]

Hainomers:
Hainomers are newer bio active materials obtained by incorporating hydroxyapatite within glass ionomer powder. They find their main applications in oral and maxillofacial surgery where they are used as bone cements. In the further they can also be used a s retrograde filling materials. They play the role by directly bonding to the bone hence affecting its growth and development. [26]

Chlorhexidine impregnated GIC:

This was developed to increase the anti cariogenic properties of conventional GIC. Chlorexhexidine impregnated GIC is still in the developmental stages. It is being tested on cariogenic organisms. [27]

Proline Containing Glass Ionomer Cement:

These are GIC which contain amino acids, which provides better surface hardness properties than commercially available GIC. This fast-set glass ionomer showed increased water absorption without adversely affecting the amount of fluoride release. It's greatly biocompatible and can be used as a dental restorative material and also as a bone cement as it has very low cytotoxicity. [28]

CPP :

CPP is an ACP containing GIC. Casein phosphopeptide-amorphous calcium phosphate is incorporated into a glass-ionomer cement. 1.56% w/w CPP-ACP is incorporated into the GIC, which significantly increased the microtensile bond strength by 33% and compressive strength by 23% and significantly enhanced the release of calcium, phosphate, and fluoride ions at neutral and acidic pH. [29]

Zirconia Containing GIC:

Zirconia containing GIC is a potential substitute for miracle mix. The Diametral tensile strength of zirconia containing GIC significantly higher than that of Miracle mix due to better interfacial bonding between the particles and matrix.[30].

NANO Bioceramic Modified GIC:

This contains Nano hydroxyapaptite / fluorapatite particles added to FUJI II GIC. 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). [31]

Calcium Aluminate GIC:

This is a hybrid product with a composition containing calcium aluminate and GIC, designed for luting fixed prosthesis.

The calcium aluminate component is made by sintering a mixture of high-purity Al_2O_3 and CaO (approximately 1 : 1 molar ratio) to create monocalcium aluminate. The main ingredients in the powder of this hybrid cementare calcium aluminate, polyacrylic acid, tartaric acid,strontium-fluoro-alumino-glass, and strontium fluoride. [32] The liquid component contains 99.6% water and 0.4% additives for controlling setting.The calcium aluminate contributes to a basic pH during curing, reduction in microleakage,excellent biocompatibility, and long-term stability and strength. [33]

Nanocomposites:

Nanocomposites and nano filler particles were developed using advanced Methacrylate resins and curing technologies. Nanoclusters and nanomeric particles are the two types of nano filler particles. The nanocomposite used in dentistry has high translucency, high polish and polish retention similar to microfilms, whilst also maintaining physical properties and resistance equivalent to those of several hybrid composites. The strength and aesthetic properties of nanocomposites makes it a good choice of restorative material for both anterior and posterior teeth. [34,35]. The advantages of nano composites to its counterparts are, Improved mechanical characteristics, Good thermal stability , Corrosion resistance, Increased Translucency and Improved handling properties. The only disadvantage being that it's more expensive than its counterparts owing to nanotechnology. [36].

Antimicrobial composite:

Incorporation of materials like silver and other antibiotics into composite gave it antimicrobial properties. Silver and titanium particles were added to the composite to give it antimicrobial properties, which was based on the contact mechanisms. [37]

Self healing composite:

Epoxy Resin composite is one of the first self-repairing or self-healing synthetic materials which is similar to resin-based dental material. Incase crack occurs in the epoxy composite material, some of the microcapsules are destroyed near the crack which releases the resin. The crack is filled by resin and reacts with a Grubbs catalyst dispersed in the epoxy composite , which results in polymerization of the resin and repair of the crack. [38]

This type of restorative can prove advantageous to prevent deterioration of restorative materials due to biodegradation, erosion, internal stress and other forces that cause fracture and degradation of the restorative material.

Conclusion:

Necessity is the mother of all inventions, in this present world where there is always a better option, abundant advances are happening in the field of dentistry to keep up with the latest trends and needs. It is slowly evolving from amalgam to nanocomposites with better biocompatibility and greater strengths. Glass Ionomers have evolved to become more user friendly over the years, while retaining their unique characters over contemporary restoration situations. Currently, nanotechnology is being employed to make better restorative materials. Unlike olden times, now there are a plethora of

restorative materials available for the clinician which offer advantages to both the patient and the dentist. And this can only be attributed to the recent advances in the dental cements.

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