REVIEW ARTICLE

RECENT ADVANCES AND MODIFICATIONS OF DENTAL RESTORATIVE MATERIALS - A REVIEW

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ARTICLE INFO	ABSTRACT
	The dental restorative materials represent a unique class of biomaterials with some restrictions in physical, mechanical and biological properties like biocompatibility, aesthetics, and ultimate material properties. Fortunately, the dental restorative materials have been the focus of a great deal of research in recent years with the goal of improving restoration performances by changing the initiation systems (composite), fillers (GIC) and by developing novel polymerization strategies (composites) etc. Here, we review the recent modifications made in different dental restorative materials.

INTRODUCTION

Dental materials are especially fabricated materials, designed for use in dentistry. There are many different types of dental restorative materials, and their characteristics vary according to their intended purpose. Examples include Amalgam, compositeresin, glass ionomer cement, resin modified glass ionomer cement (RMGIC), compomers which fall under the direct restorative materials. The indirect restorative materials include porcelain (ceramic), composite resin, ceramic-resin hybrids, gold, other historical fillings such as platinum, aluminum, tin and iron, thorium, lead and tungsten etc. These materials which are used for fillings etc have a finite lifespan: an average of 12.8 years for amalgam and 7.8 years for composite resins. However, the lifespan of a restoration also depends up on how the patient takes care of the offended tooth which was restored and do not exert too much pressure by eating really hard food substances (Van Nieuwenhuysen *et al.*, 2003).

Amalgam

Amalgam is a metallic filling material composed from a mixture of mercury (from 43% to 54%) and powdered alloy made mostly of silver, tin, zinc and copper, commonly called the amalgam alloy (WHO). Amalgam does not adhere to tooth structure without the aid of cements or use of techniques which lock in the filling, using the same principles as a dovetail joint etc.

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Amalgam is still used extensively in many parts of the world because of its cost effectiveness, superior strength and longevity. However, the metallic colour is not aesthetically pleasing and tooth coloured alternatives are continually emerging with increasingly comparable properties. Due to the known toxicity of the element mercury, there is some controversy about the use of amalgams. The Swedish government banned the use of mercury amalgam in June 2009 (Sweden will ban, 2009). Research has shown that, while amalgam use is controversial and may increase mercury levels in the human body, these levels are below safety threshold levels established by the WHO and the EPA. However, there are certain subpopulations who, due to inherited genetic variabilities, exhibit sensitivity to mercury levels lower than these threshold levels. These particular individuals may experience adverse effects caused by amalgam restoration. These include myriad neural defects, mainly caused by impaired neurotransmitter processing (Woods, 2014).

Resin Coated Amalgam

To overcome the limitation of microleakage with amalgams, a coating of unfilled resin over the restoration margins and the adjacent enamel, after etching the enamel, has been tried. Although the resin may eventually wear away, it delays microleakage until corrosion products begin to fill the tooth restoration interface. Mertz-fairhurst and others evaluated bonded and sealed composite restorations placed directly over frank cavitated lesions extending into dentin versus sealed conservative amalgam restorations and conventional unsealed amalgam restorations. The results indicate that both types of

sealed restorations exhibited superior clinical performance and longevity compared with unsealed amalgam restorations over a period of 10 years (Mertz-Fairhurst, 1998).

Fluoridated amalgam

Fluoride, being cariostatic, has been included in amalgam to deal with the problem of recurrent caries associated with amalgam restorations. The problem with this method is that the fluoride is not delivered long enough to provide maximum benefit. Several studies investigated fluoride levels released from amalgam (Forsten *et al.*, 1990; Skartveit *et al.*, 1985; Tveit *et al.*, 1981; Garcia-Godoy *et al.*, 1991; Garcia-Godoy *et al.*, 1990). These studies concluded that a fluoride containing amalgam may release fluoride for several weeks after insertion of the material in mouth. As an increase of up to 10-20-fold in the fluoride content of whole saliva could be measured, the fluoride release from this amalgam seems to be considerable during the first week. An anticariogenic action of fluoride amalgam could be explained by its ability to deposit fluoride in the hard tissues around the fillings and to increase the fluoride content of plaque and saliva, subsequently affecting remineralization. In this way, fluoride from amalgam could have a favorable effect not only on caries around the filling but on any initial enamel demineralization. The fluoride amalgam thus serves as a "slow release device" (Skartveit *et al.*, 1985).

Bonded Amalgam

Conventional amalgam is an obturating material as it merely fills the space of prepared cavity, and thus, does not restore the fracture resistance of the tooth, which was lost during cavity preparations. In addition, the provision for adequate resistance and retention form for amalgams may require removal of healthy tooth structure. Further, since amalgam does not bond to tooth structure, microleakage immediately after insertion is inevitable. So, to overcome these disadvantages of amalgam, adhesive systems that reliably bond to enamel and dentin have been introduced. Amalgam bond is based on a dentinal bonding system developed in Japan by Nakabayashi and co-workers (Nakaabayashi *et al.*, 1992). The bond strengths recorded in studies have varied, approximately 12-15 MPa, and seem to be routinely achievable (Ratananakin *et al.*, 1996 Imbery *et al.*, 1995 and Ramos *et al.*, 1997) Using a spherical amalgam in one study of bonded amalgam, Summitt and colleagues reported mean bond strength of 27 MPa. The authors believed that this higher bond strength was achieved because the bonding material was refrigerated until immediately before its use (Diefenderfer *et al.*, 1997).

Bond strengths achieved with admixed alloys tend to be slightly lower than those with spherical alloys (Summitt *et al.*, 1988). One study compared post-insertion sensitivity of teeth with bonded amalgams to that of teeth with pin-retained amalgams. After 6 months, teeth with bonded amalgams were less sensitive than teeth with pin-retained amalgams. This difference in sensitivity was not present 1 year after insertion. This is possibly because of corrosion products in nonbonded amalgam restorations filling the interface, and thus, decreasing microleakage and sensitivity (Summitt *et al.*, 1997). If bonding proves successful over the long term, method of mechanical retention can be eliminated, thus reducing the potential for further damage to tooth structure that occurs with pin placement or use of amalgapins. If mechanical retention is not needed, cavity design can allow more sound tooth structure to be preserved (Berry *et al.*, 1998).

Consolidated silver alloy systems

One amalgam substitute being tested is a consolidated silver alloy system developed at the National Institute of Standards and Technology (Eichmiller *et al.*, 1998). It uses a fluoroboric acid solution to keep the surface of the silver alloy particles clean. The alloy, in a spherical form, is condensed into a prepared cavity in a manner similar to that for placing compacted gold. One problem associated with the insertion of this material is that the alloy strain hardens, so it is difficult to compact it adequately to eliminate internal voids and to achieve good adaptation to the cavity without using excessive force (Berry *et al.*, 1998).

Glass ionomer cements

The concept of using "smart" materials in dentistry has attracted a lot of attention in recent years. Conventional glass-ionomer (GI) cements have a large number of applications in dentistry. They are biocompatible with the dental pulp to some extent. Clinically, this material was initially used as a biomaterial to replace the lost osseous tissues in the human body. These fillings are a mixture of glass and an organic acid. Although they are tooth-colored, glass ionomers vary in translucency. Although glass ionomers can be used to achieve an aesthetic result, their aesthetic potential does not measure up to that provided by composite resins. The cavity preparation of a glass ionomer filling is the same as a composite resin. However, one of the advantages of GI compared to other restorative materials is that they can be placed in cavities without any need for bonding agents (Woods, 2014).

Conventional glass ionomers are chemically set via an acid-base reaction. Upon mixing of the material components, there is no light cure needed to harden the material once placed in the cavity preparation. After the initial set, glass ionomers still need time to fully set and harden. The advantages are glass ionomer can be placed in cavities without any need for bonding agents, they are not subject to shrinkage and microleakage, as the bonding mechanism is an acid-base reaction and not a polymerization reaction.(GICs do not undergo great dimensional changes in a moist environment in response to heat or cold and it appears heating results only in water movement within the structure of the material. These exhibit shrinkage in a dry environment at temperature higher than 50C, which is similar to the behavior of dentin, glass ionomers contain and release fluoride, which is important to preventing carious lesions. Furthermore, as glass ionomers release their fluoride, they can be "recharged" by the use of fluoride-containing toothpaste. Hence, they can be used as a treatment modality for patients who are at high risk for caries. Newer formulations of glass ionomers that contain light-cured resins can achieve a greater aesthetic result, but do not release fluoride as well as conventional glass ionomers.

The disadvantages are most important disadvantage is lack of adequate strength and toughness. In an attempt to improve the mechanical properties of the conventional GI, resin-modified ionomers have been marketed. GICs are usually weak after

setting and are not stable in water; however, they become stronger with the progression of reactions and become more resistant to moisture. New generations: The aim is tissue regeneration and use of biomaterial in the form of a powder or solution is to induce local tissue repair. These bioactive materials release chemical agents in the form of dissolved ions or growth factors such as bone morphogenic protein, which stimulates activate cells. Glass ionomers are about as expensive as composite resin. The fillings do not wear as well as composite resin fillings. Still, they are generally considered good materials to use for root caries and for sealants.

Resin Modified Glass Ionomer Cements (RMGIS)

RMGIs were produced by adding methacrylate to polyacrylic acid. Some of them are light-cured, which is supplementary to the basic acid-base reaction. In comparison, polyacid-modified composite resins consist of commonly used macromonomers in composite resins, which include Bisphenol A-Glycidyl dimethacrylate or urethane dimethacrylate along with small amounts of acidic monomers (Xie *et al*., 2000; Nagaraja Upadhya *et al*., 2005). They have the same ion-releasing glass as filler particles used in conventional GI, but in small sizes. The initial setting reaction is triggered by the light, which is followed by acid-base reaction after absorption of water (Wiegand *et al*., 2007). A large number of researchers have reported that RMGIs can release fluoride at a rate comparable to that by conventional GI. (Wiegand *et al*., 2007; Robertello *et al*., 1999). However, this release is not only under the influence of formation of complex fluoride derivatives with their reaction with polyacrylic acid, but also it might be affected by the type and amount of the resin used in the light polymerization (Tjandrawinata *et al*., 2004; Musa *et al*., 1996 and Momoi *et al*., 1993).

Release of fluoride from various RMGIs during the first 24 h is maximum with 5-35 µg/cm2 depending on the storage environment (Wiegand *et al*., 2007; Attar *et al*., 2003; Karantakis *et al*., 2000; Forsten *et al*., 1994 and Hayacibara *et al*., 2004). Daily fluoride release begins from 8 ppm to 15 ppm on the 1st day and decreases to 1-2 ppm on the 7th day and stabilizes in 10 days to 3 weeks (Robertello *et al*., 1999; Attar *et al*., 2003; Yap *et al*., 2002; Gao *et al*., 2000).

Compomers

Dental compomers are materials which are used in dentistry as restorative material. They were introduced in the early 1990s as a hybrid of two other dental materials: dental composites and glass ionomer cement. They are also known a polyacid-modified resin composites. They are used for restorations in low stress–bearing areas. The composition of compomers is similar to that of a dental composite however it has been modified, making it a polyacid-modified composite. This results in compomers still requiring a bonding system to bond to tooth tissue. Compomer contains poly acid–modified monomers and fluoride-releasing silicate glasses. An acid-base reaction occurs as the compomer absorbs water after contact with saliva, which facilitates cross-linking structure and fluoride release. Compomers release some fluoride ions, like a glass ionomer cement. The level of this fluoride release however is only around 10% of that of a glass ionomer, which makes it less useful for deciduous restorations. It has been

shown to have no advantage over an amalgam restoration with a fluoride releasing bonding agent, which releases mercury and fluoride (Trachtenberg *et al*., 2009) Compomers also do not have the ability to 'recharge' their fluoride ion content with topically applied fluoride from toothpaste etc., like glass ionomer cements; this is another limit on their efficacy. Compomers are recommended for patients at medium risk of developing caries. Handling and ease of use of composites is generally seen as good by dental professionals (Van Noort and Richard, 2007). Compomers are available in both normal and flowable forms, with the manufacturers of the flowable compomers claiming that they have the ability to shape to the cavity. Compomers are tooth coloured materials, and so their aesthetics can immediately be seen as better than that of dental amalgams. It has been shown that ratings in various aesthetic areas are better for compomers than resin modified glass ionomer cements (Folwaczny *et al*., 2001). Compomers are also available in various non-natural colours from various dental companies for use in deciduous teeth.

Metal Modified GIC

It is also called as miracle mix or silver alloy admix GIC. Sced and Wilson in 1980 spherical silver amalgam alloy into type 2 GIC powder in a aratio of 7:1. The powder consists of glass about 17.5%, silver about 82.5% and the particle size of silver is 3-4 mu m. The liquid component consists of Aqueous solution of copolymer of acrylic acid and or maleic acid about 37% and tartaric acid 9%. The disadvantages of the metal modified GIC are poor resistance to abrasion, resistant to burnishing and poor aesthetics.

Glass Cermet

Also called as cermet ionomer cements. McLen and Gasser in 1985 first developed this material. Fusing the glass powder to silver particles through sintering that can be made to react with polyacid to form the cement. Sin tering is done at high pressure more than 300Mpa and at a temperature of 800 degree centigrade which is ground to fine powder particle size of 3.5 mu m. 5% titanium dioxide is added ti improve aesthetics. It has excellent handling characters.

The indications are cre build-up material, root caps of teeth under over dentures, class 1 cavities in primary teeth, lining of SAF, preventive restoration and temporary posterior restoration. The contraindications include anterior restorations, areas subjected to high occlusal loading. The properties include strength which is both tensile and compressive strength is greater than conventional glass ionomer cement. The modulous of elasticity i.e tends to be relatively lower than conventional GIC. The abrasion resistance is greater than conventional GIC due to silver particle incorporation. The radiopacity, silver cement radiopacity is equal to that of dental amalgam. The fluoride release for miracle mix is in about 440 ug in 2 weeks and 650 ug in 1 months. The fluoride release for cermet is about 3350 ug in 2 weeks and about 4040 ug in 1 months.

Composite Resins

Composite restorative materials represent one of the many successes of modern biomaterials research, since they replace biological tissue in both appearance and function. At least half

of posterior direct restoration placements now rely on composite materials (Sadowsky, 2006). Unfortunately, d.emands on these restorations with regard to mechanical properties, placement, and need for *in situ* curing leave significant room for advancements, particularly with respect to their mechanical properties, polymerization shrinkage and polymerization-induced stress, thermal expansion mismatch, fracture, abrasion and wear resistance, marginal leakage, and toxicity (Anseth *et al*., 1995; Lovell *et al*., 2001a; Ferracane *et al*., 2008 and Sadowsky *et al*., 2006). Ultimately, these shortcomings reduce a restoration's lifetime and represent the driving force for improvement in dental composites. Clinical evaluations (Bernado *et al*., 2007) and laboratory-based studies focused on composite durability (Drummond, 2008) also continue to highlight this need for new materials. A 2001 review discussed development of polymeric composite restorative materials (Monzer *et al*., 2001). The article focused on methods for reducing polymerization shrinkage and achieving improvements in biocompatibility and wear resistance. Here, the focus is on reviewing advances from the last five years. We focus this review on recent research aimed at improving one or more attributes of dental restorative materials. Given the focus on recent research, only a very few of these developments have already been incorporated into clinical applications.

Fillers and filler modifications

Research on fillers constitutes a large potential source of improvement in composite based dental restoratives. In fact, a significant fraction of the practically implemented improvements in composites in recent decades has occurred in the nature, type, size distribution and surface modification of the fillers. A review (Klapdhor and Moszner, 2005), focused on inorganic filler components of dental composites and repeated filler composition, morphology and loading content with composites conveyed to composites. This review also examined a variety of saline surface modifications and sol-gel-based hybrid inorganic/organic materials. Here, we survey continued developments repeated to filled dental polymers, including several recent approaches that involve the analytical characterisation of composite materials as well as the implementation of advances in filler technology that result in improved composite restorative.

Nano fillers in composite resins

Significant attention has been devoted to nanofilled materials, including improvementsincorporation of nanofillers into commercial composite materials and research aimed at the development of new nanofillers. A recent review focused on nanofilled dental composite materials (Soh *et al*., 2006), and a separate report centered on how nanofillers affect composite mechanical properties and behave distinctly differently compared with micro- or macro-scale fillers (Crosby *et al*., 2007). Nano-sized fillers can be categorized as either isolated discrete particles, with dimensions of approximately 5 to 100 nm, or fused aggregates of primary nanoparticles, where the cluster size may significantly exceed 100 nm. The enormous rise in filler surface area and the corresponding thickening effect on composite paste consistency associated with decreasing filler size limit the content of discrete nanoparticles to relatively low loading levels, whereas high contents of

nanoparticle clusters are manageable with appropriate surface treatment. A spatially resolved nanoindentation study examined Filtek Supreme XT (A3 Dentin) as a nanofilled composite and demonstrated significant differences in the dynamic complex modulus as a function of positioning within the matrix, within a filler cluster, or at the matrix-filler interface (Ilie *et al*., 2009). A study on the influence of mono-, bi-, and tri-modal distributions of fillers on the wear properties of composites showed that filler size and shape significantly influence wear resistance, with the inclusion of nano-sized filler a critical feature, often leading to enhanced properties (Turssi *et al*., 2005). A similar dependence of toothbrush abrasion resistance on the presence of nanoparticles in commercial dental composites has been shown (Cavalcante *et al*., 2009).

Additional fillers and composite Performance

The use of mesoporous silica fillers has been suggested as a means to eliminate the silane-mediated interface between filler and matrix, while providing a potentially more stable direct mechanical interlocking. A study evaluating the use of silica particles with interconnected pore structures as well as a non-porous silanized silica filler showed that optimized filler loading and mechanical reinforcement were achieved with a mixture of the two fillers (Samuel *et al*., 2009). The potential anisotropic effects of fiber-based fillers on polymerization shrinkage have also been demonstrated (Tezvergil *et al*., 2006) as well as the interactions between fibrous and particulate fillers in complex composite materials (Gauthier *et al*., 2009). Electrospun continuous nano-fiber-reinforced dental polymers have also been evaluated, with a focus on the fiber-matrix interface being a critical feature (Gao *et al*., 2008; Lin *et al*., 2008). A composite wear study with bioactive glass-ceramic fillers was conducted, and it demonstrated improved performance at low levels of surface porosity, but reduced wear resistance in the case of highly porous filler surfaces (Tan *et al*., 2010). An examination of nano-fibrillar silicate crystals showed the potential for improved mechanical properties, but also highlighted the difficulties of obtaining uniform dispersion of the nano-structures in the matrix (Tian *et al*., 2008). The combination of calcium phosphate nanoparticles with silicon nitride whiskers produced a composite material with caries inhibition potential and good mechanical properties (Xu *et al*., 2009). Other composites designed to promote remineralization were also examined (Mehdawi *et al*., 2009).

The influence of filler particles on the rheology and handling properties of dental composites has been extensively evaluated. Filler incorporation converts the Newtonian behavior of unfilled resins to composites that exhibit shear-thinning and thixotropic behavior, with micro-sized fillers inducing relatively subtle effects compared with the dramatic changes associated with nanofillers (Lee and Bowman, 2006; Beun *et al*., 2009). One investigation of commercial composite materials used an oscillatory compressive rheometer to highlight the substantial differences in viscoelastic behavior of these uncured composite pastes (Lee *et al*., 2007). Additional studies correlating the rheological properties of commercial composites with their time-dependent slumping resistance have been conducted (Lee *et al*., 2008). Related to this, a method to quantify the effects of particle size and morphology on handling properties of experimental composites was developed.

The maximum force and work involved with the separation of a probe from uncured paste are related to the 'stickiness' of the composite, with differences noted between spherical and irregular particulate fillers (Kaleem *et al.*, 2009).

Macrohybrid composites

These were the first type of resin composite marketed in the 1960's for filling front teeth. As the name implies, the particles in a macrofill are fairly large. Crystalline quartz was ground into a fine powder containing particles 1 to 50 microns (μM) in diameter. (A micrometer, also called a micron, is a millionth of a meter, or a thousandth of a millimeter. An average grain of salt is about 60 microns.) The 1μM size is critical, since particles larger than this are visible to the naked eye. Particles 1μM and larger are called macro particles, while those smaller than 1μM are called micro particles. The acrylic matrix in a composite tends to shrink on setting. Excessive shrinkage in a filling material is undesirable because it would either leave a gap between the tooth surface and the filling material, or, if well bonded, would cause cracks in the tooth structure as the filling contracts during setting. Furthermore, any filling made from resin alone would wear very rapidly in service. The inclusion of the glass particles reduces these problems because they reduce the volume of acrylic, and act as a mechanical "skeletal structure" within the composite to help maintain the original volume of the filling when it sets. The advantage of large particle size is that large numbers of particles can be incorporated into the paste without making it too stiff to manipulate. Macrofills are 70% to 80% glass by weight, 60% to 65% by volume. Unfortunately, macrofill composites have two undesirable qualities:□ Due to large particle size, macrofills are not very polishable. As a result, they feel rough and are prone to accumulation of plaque and stain. The relatively soft acrylic polymer tends to wear below the level of the glass particles, which constantly pop out of the surface leaving holes in their place. This leads to a surface which, on a microscopic level, looks like a series of craters interspersed with boulders. This type of surface is prone to staining.

But wear is the major disadvantage of macrofilled composites. The constant loss of the glass particles exposes more and more of the soft plastic matrix to the abrasive forces encountered in the mouth, and the restoration slowly wears away over time. However, the large particle size has one major advantage over small particle size. You can pack them more tightly into the resin matrix without the paste becoming too thick for the dentist to handle. This becomes more difficult to accomplish with small particle size. This is explained in detail below. More glass in the mixture reduces setting shrinkage. A composite restoration wears exclusively because the glass particles are slowly dislodged from the surface leaving more of the soft resin matrix exposed to wear factors. If there were a way to keep the particles in place forever, the restoration would never wear down. In theory, the less acrylic and the more glass a composite contains, the better. An ideal composite filling would contain only glass, and no acrylic at all. This, of course, is impossible, since the resin is the material used to glue the silica particles together. It is also the component that gives the unpolymerized material the handling characteristics that allow the dentist to work with it in the first place. The tendency for large glass particles to dislodge from the surface of macrofilled

restorations makes them unsuitable for posterior restorations, since the occlusal (top) surfaces of the back teeth receive a lot of abrasive challenges. Any filling that wears excessively would allow the bite to change, and the teeth will move over time. In persons who brux (grind their teeth), this could cause a collapsed bite and contribute to Temperomandibular Joint Dysfunction (TMJ, or TMD). The first macrofills appeared on the market in the mid 1960's. Most older dentists affectionately remember them by their brand names, Adaptic and Concise. both of these products had the additional disadvantage of containing no radiopaque materials which made it difficult to distinguish from decay on x-rays.

Bulk Fill Composites

Direct restorations are one of the most commonly used materials for most restorative practices today. For years, dental amalgams were the standard of care for posterior fillings but over recent years, composite resins are taking over as the first choice with patients and dentists. Routine Class I and II restorations can also create some challenges for those dentists who are not used to the specific placement and handling requirements. The early years of composite resins created challenges because of material composition, bonding, curing, finishing and polishing techniques. After years of development we can now achieve predictable success with our placement and bonding protocols. The downside of composite resins is the technique sensitivity that many dentists find more painstaking than placing a traditional amalgam. If our patients didn't insist on non-metal, esthetic alternatives, we may still be doing amalgams at the same rate we did 10- 15 years ago. There have been many advances to composite resins in terms of strength, shrinkage, polishability, durability and esthetics. However, for most, a methodical layering technique is required for success.

In a fast-paced restorative practice it would not be uncommon to find multiple patients each day who require several posterior restorations to be done in one appointment. The ability to place these restorations in a simple, predictable and timely fashion would be beneficial to not only the practice, but also those patients who really don't wish to sit in a chair longer than they have to. For that reason, the development of bulk fill composites has begun to "change the game" for direct restorative dentistry. Dentists want predictability, ease of handling, and confidence in durability and esthetics. In addition, they want some convenience and simplicity to allow for the time-savings experienced when patients were willing to accept a metal filling. Bulk fill composite resins were developed to reduce the number of increments required to complete a restoration. Recent literature is quite clear that this trend is growing as manufacturers continue to develop an array of choices for the market. The key features are related to the improved polymerization shrinkage and the greater depth of cure. Both of these features allow dentists to have the confidence to place fewer and larger increments with predictability.

The fact is, all composite resins exhibit some polymerization shrinkage and for that reason, multiple thin increments are recommended to avoid the detrimental effects of shrinkage. Furthermore, placing heavier and more compactable composites can provide the feel of placing an amalgam, but can

lead to challenges in terms of creating voids and bubbles in the restorations. Bulk fill resins help counter those challenges by their improved chemical and physical properties. There are also hybrid/nano and flowable. The key properties of bulkfill composites are First, they should have reduced polymerization shrinkage to minimize the chance of failure due to microleakage. Second, they should have a reasonable depth of cure for the ability to be placed in larger increments for convenience. Third, they should be flowable enough to reach all the areas of the preparation without creating voids. The ability to adapt to the preparation is paramount. Fourth, they should have excellent physical properties to allow confidence in terms of wear and function. Finally, it would be great to have esthetics that allow the material to blend into the adjacent tooth without having to layer multiple shades. The benefits of the bulkfill composites are one-step placement, no additional capping layer, excellent adaptation without additional expensive dispensing devices, stress relief to enable up to 5 mm depth of cure, excellent handling and sculptability. available in capsule or syringe delivery in 5 shades: A1, A2, A3, B1, C2.

Flowable Composites

Flowable composites have an abundance of uses in dental procedures including as liners and bases as well as for temporary crown repair, veneer cementation, pit and fissure sealing, porcelain repair and small core build up. Flowable composites are probably best known however for their use in Class III, Class IV and Class V restorations. Characteristics of flowable composites may include radiopaque, various viscosity for superior flowability or packing, fluoride release and high polishability. Flowable composites may be self-cure, light cure or dual cure with a range in curing times. Esthetics are an important aspect in dental restorations, be sure a variety of shades are available for a perfect match. Most flowable composites can be polished to a long lasting high-gloss finish. Flowable composites are mostly delivered via syringe, whether refillable or disposable. When choosing a flowable composite, be sure to research the best composite for the dental procedures in mind. Most vendors provide specs on hardness, comprehensive strength, flexural strength and modulus of elasticity as well as an abundance of other features.

Polishablilty of the surface of the restoration is important for aesthetic and functional purposes. The surface should be able to have a smooth lustrous surface and be able to maintain this desired characteristic. The effect of one-step polishing systems on the surface roughness of various flowable composites. The one- or 2-step polishing systems are a good choice for the polishing of flowing composites.

Giomers

Although frequently used to describe the new category of restoratives, the term GIOMER is less of a category and more an ingredient. Succinctly put, GIOMER refers to any product that contains surface pre-reacted glass (S-PRG). S-PRG fillers are nano-sized glass filler particles that undergo an acid/base reaction receiving a surface modified layer to help block moisture before incorporation into the resin. This process differs greatly from GI or compomers, which achieve an acid/base reaction only after placement, following a light cure,

and after they absorb water. Following water sorption, fillers in GIs and compomers immediately swell, causing a rapid breakdown in both strength and esthetics. Through pre-reaction and the addition of a surface modified layer, GIOMERs offer stable fluoride rechargability similar to GIs, but with vast improvement to strength and aesthetics.

Sustained fluoride recharge

Unlike other composite resin materials, GIOMERs are unique in their ability to recharge fluoride indefinitely. S-PRG filler particles act as a fluoride reservoir that recharge with brushing or rinsing with fluoridated products. Fluoride then releases when acid levels rise, providing sustained preventative benefits to adjacent tooth structure over the life of the restoration. Independent evaluation of S-PRG materials conducted by the University of Florida and published in JADA, translates this benefit to clinical relevance. At eight years, none of the restorations failed, no sensitivity was reported, anatomical form was well maintained and most notably, no secondary caries were present in any of the patients.

Application of GIOMERs

Dental applications for GIOMER products are limited only by the imagination. Shofu has successfully incorporated the material into composite resins such as BEAUTIFIL Flow Plus and BEAUTIFIL II, and into the bonding agent FL Bond II with great clinical success. Further applications are under development.

ORMOCER

ORMOCER stand for ORganically Modified CERamic. It is a three dimensionally cross-linked copolymer. Ormocer are advanced filling materials for use in dentistry which, due to their innovative matrix technology and filler particles represent state-of-the-art science. The Ormocer class of materials was developed by the Fraunhofer Silicate Research Institute at Wurzburg, Germany and is patented. The Ormocer structure consists of a special pre-shaped copolymeric network. Unlike conventional polymers, Ormocers have a large back bone, which is functionalized with polymerizable organic units. This produces three-dimensional polymeric composites. Filler particles are incorporated into this cross-linked inorganic and organic network matrix. Ormocers are fully polymerised materials. Ormocers undergoes 1.97% volume shrinkage which is lowest value recorded so far for a resin based filling material. Due to their cross-linking and chemical nature, Ormocers ensure that it is a highly biocompatible filling material. Their advantages compared to conventional composites are: outstanding biocompatibility, minimal shrinkage, resistance to masticatory loading and esthetics resembling natural teeth. It is virtually impossible to differentiate between teeth filled with Ormocers and caries-free, non-filled natural teeth.

Conclusion

With advances in dental research, Newer dental materials have made their way into the dental market. Each newer restorative material introduced has its set of benefits and shortcomings. Restorative materials should be selected based on the clinical

condition and requirements of the particular tooth to be restored. Clinician should have a thorough understanding of the indications and contraindications of the dental restorative material being used by them. This review provides a comprehensive understanding of the recent advancements and modifications in field of restorative materials.

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