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Recent Advances in Direct Esthetic Material: Review

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Abstract

Marked changes have occurred in the use of restorative materials during the past 10 to 20 years and esthetic considerations are growing in importance for the restoration of anterior as well as posterior teeth in recent years. The development in new materials and interest in esthetic dentistry has dramatically increased. .One of the basic requirements of esthetics in dentistry is to restore anterior Teeth and any extra orally conspicuous aspects of posterior teeth with a restorative material that has the same color, shade and all visual perceptions as that of adjacent tooth structure while keeping them unchanged in function.

The development of dental restorative composite system by Bowen and its introduction to dentistry was so

successful that it soon replaced silicates and acrylic resin as anterior esthetic restorative material. Dental composites have advantages as a restorative material in terms of esthetics, conservation of tooth structure, adhesion to tooth structure, and low thermal conductivity. These are most widely used aesthetic materials now a days and were introduced to overcome the shortcomings of amalgam.

Dental composites have advantages as a restorative material in terms of esthetics, conservation of tooth structure, adhesion to tooth structure, and low thermal conductivity. Earlier composites lack in mechanical properties to withstand the masticatory forces. Various filler particles have been added to composite to improve their physical and mechanical properties such as compressive and flexural strength and hardness. This article is a review of numerous types of composites that are technologically advanced to modify their properties.

Introduction

Nearly forty-five years back in 1959 Skinner stated, " The esthetic quality of a restoration may be as important to the mental health of the patient as the biological and technical qualities of the restoration are to his/her physical or dental health", thus emphasizing the significance of estheticsl.

In our modern competitive society, a pleasing appearance often means the difference between success and failure in both our personal and professional lives2 .

To find an esthetic material having similar physical and chemical properties to tooth tissue, replaces lost and damaged tooth structure, at the same time will minimise the risk of further damage3. is one one of the major quests in conservative dentistry.

In 1955 Buonocore showed that there is micromechanical adhesion between resin and enamel following acid etching. Resin-based composites became available in the mid-1960s and glass-ionomer cements were introduced in the mid-1970s3.

Composite resin material is the most innovative esthetic material available today, continuously evolving and has assumed a thrust in restorative dentistry. The search for an ideal esthetic material for restoring teeth has resulted in significant improvements in both esthetic materials and techniques for using them1 .As it is said that "Necessity is the mother of invention" new materials have been developed to overcome the drawbacks of composites & to increase the longevity of composites as restorative material.

The advances in the restorative materials and bonding techniques have changed the concept of "EXTENSION FOR PREVENTION" as "RESTRICTION WITH CONVICTION.

Direct Aesthetic Restorative Material

Restoration of small portion of tooth can be easily accomplished by designing a tooth preparation with retention features and restoring it with Apliable material that is capable of hardening in situ while in moldable stage, the material can be adapted to tooth structure and shaped to recreate normal anatomic contours.15 This process is called direct restorative dentistry.

According to ANUSAVICE, the term composite material may be defined as a compound of two or more distinctly different materials with properties that are superior or intermediate to those of individual constituents.9

Ceromers

Ceromers or Ceramic Optimized Polymer are micro filled hybrid resins, introduced by Ivoclar to illustrate their composite Tetric Ceram. They are also known as universal composite resins. Ivoclar in

cooperation with several universities has developed advanced polymer systems and ceramic fillers from which high performance Ceromers (ceramic optimized polymers) have been produce.[10]

This material consists of a paste containing barium glass, spheroidal mixed oxide, ytterbium tri fluoride, and silicon dioxide (57 vol%) dimethacrylate monomers (Bis-GMA & urethane dimethacrylate).

Uses

- Ceromer can be used for veneers, inlay/onlay without a metal framework[11]
- In conjugation with Fiber Reinforced composite framework for inlays/onlay, crowns and bridges (3 unit) and for crown and bridges including implant restorations on a metal framework.

Smart Composites / Stimuli Response

Ariston pHc in 1998 introduced this class of composite. Ariston is an ion releasing composite material. It releases functional ions like fluoride, hydroxyl, and calcium ions as the pH drops in the area immediately adjacent to the restorative materials, as a result of active plaque. [12]

Smart composite are also known as intelligent composites. These are the active dental polymers containing bioactive amorphous calcium phosphate (ACP) filler that are capable of responding to environmental pH changes through releasing calcium and phosphate ions and thus become adaptable to the surroundings. External stimuli like Temperature, pH, mechanical stress, moisture, or electric or magnetic fields are the most important factors that affect antimicrobial compound or fluoride. 13 compound or fluoride.[13]

These materials “release on command” ions, especially when the pH is less than 5.5, a significant number of ions than that at the neutral pH. Therefore, it provides additional caries protection. It works by reducing the formation of secondary cariesat the margin of a restoration by inhibiting bacterial growth, based on the developed alkaline glass filler designed for this. Thus resulting in a reduced buffering of the acid and demineralization produced by microorganisms responsible for caries.[14] The physical properties of this material are comparable to those of other composites. The fluoride release from this material is claimed by the manufacturer to be lower than conventional glass-ionomers but more than that of compomers. Although it had promising properties, this resin composite was not very well accepted in the dental community, it did not meet the esthetic need, and it was difficult to handle.[15,16]

Ormocers

Organically Modified Ceramic is a new advancement for all anterior and posterior restoration which serve as an up to date replacement for amalgam, composite and compomers. ORMOCER. Dr. Herbert Wolters from Fraunhofer Institute for Silicate Research introduced this class of material in 1994.[17] This class of material represents a novel inorganic-organic copolymer in the formulation that allows for modification of its mechanical parameters. They are considered to be molecule-sized hybrid structures.[18] The inorganic-organic copolymers are synthesized from multifunctional urethane and thioether (meth) acrylate alkoxysilanes as sol-gel precursors. Alkoxysilyl groups of the silane (Organic reactive) permit the formation of an inorganic Si-O-Si network by hydrolysis and polycondensation reactions. The methacrylate groups are available for photochemical polymerization. The filler particles are 1 µm to 1.5 µm in size and the material is 77% filler weight and 61% filler volume.[19]

These molecular hybrids consist of, for example, methacrylate-terminated chains grafted on to a central

cyclic polysilioxane 2-3nm particles. The nanoparticles are dispersed on a molecular scale. These are high molecular weight, flexible, relatively low viscosity crosslinking molecules. The large spacing between crosslinks resulting from curing produces a low-level polymerization shrinkage, while the inorganic network provides abrasion resistance through its glass-like structure and low water sorption due to its hydrophobicity. As they have an unique composition, it offer characteristic advantages in comparison to conventional composites including-limited cure shrinkage, biocompatibility, better manipulation properties, and excellent esthetics. These materials are indicated for class-I to V cavities, veneering of **Self-healing or self-repairing composites** discoloured anteriors, repair of veneers, core build-up, orthodontic bonding adhesive, indirect inlays, and reconstruction of traumatically affected anteriors.[20] Eg., DEFINITE, ADMIRA FLOW

Self-healing or self-repairing composites

Materials generally degrade over time due to different physical, chemical or biological stimuli thus have a limited shelf-life. That includes Creep or fatigue, internal stress states, erosion, dissolution, corrosion or biodegradation. That can lead gradually to a deterioration of the material and subsequently failure of the material. With time many researchers have developed such a material, which can repair themselves.[15]One of the first self-repairing synthetic materials reported, interestingly shows some similarities to resin-based dental materials, since it is resin based. The self-healing and self-repairing composite is an epoxy-based system which contains resin-filled microcapsules. These microcapsules may be destroyed and release the resin when the epoxy resin undergoes crazing. Finally the resin fills those cracks and reacts with a Grubb's Catalyst which is dispersed in the epoxy composite. This may eventually polymerize the resin and repair the crack [19].

Nano Composites

Nanotechnology consists of reducing components of material to nanometric size to improve the final characteristics of a new material. Nanotechnology in composite resins can provide an extremally smaller filler particle size that can be dissolved in higher concentrations and polymerized into the resin system . in nano-filled resins, the inorganic nano-fillers are added to organic resin matrix to have the strength of inorganic material and flexibility and toughness of organic material.[12]The molecules in these materials can be designed to be compatible when coupled with a polymer and provide unique characteristics (i.e., physical, mechanical, optical). Currently, the conventional composites particle sizes are so contrasting from the structural sizes of hydroxyapatite crystals, dental tubules, and enamel rods, compromises in adhesion between the macroscopic (40-0.7 nm) restorative material and the nanoscopic (1-10 nm in size) tooth structure are potential.[14] Nanotechnology can, however, improve this continuity between the tooth structure and the nanosized filler particle and provide a more stable and natural interface between the mineralized hard tissues of the tooth and these advanced restorative biomaterials. These composites have approximately 60% volume filler loading, making the nano-filled resins as strong as the hybrid and micro-hybrid resins. The nanocomposites have nanofillers that contain nanomodifier such as the nanomers and nanoclusters that result in increased flexural strength, increased modulus of elasticity, improved wear resistance and hardness, decreased polymerization shrinkage and enhance polish ability of resin.[20]

Nanofillers may include colloidal silica or ormocers, such as Inceram X from Dentsply.Studies have shown that nanocomposites show greater fracture toughness and adhesion to tooth structure.Nano filled, and nanohybrids are commonly available nanocomposites. The average particle size of Nanofilled ranges from 1-100 nm, whereas nanohybrids are comprised of larger particles of ranging from 0.4 to 5
microns. These nanofillers present superior properties than nanohybrids .

A perfect example of this was introduced in early 2003 is, **Filtek Supreme XT**. It uses unique nanofiller technology; which is formulated with nanomer and nanocluster filler particles. Supreme is claimed to combine the strength of a hybrid and the polish of a micro fill.

Composition

Nanomers are discrete non-agglomerated and nonaggregated particles of 20-75 nm in size. Nanoclusters are loosely bound agglomerates of nano-sized particles. Nanotubes have remarkable tensile strength and could dwarf the improvements that carbon fibers brought to composite.

Advantages

Excellent handling properties, Superior translucency and esthetic appeal, excellent colour, high polish and polish retention.

- Superior hardness, flexural strength and modulus of elasticity.
- About fifty percent reduction in polymerization shrinkage.[20]

Self-adhering composites

Self- adhering composites were first introduced in 2009 by Kerr Crop. These are also known as **compobonds**. Self-adhering flow able composite combines the merits of both dental adhesives and restorative materials technologies (8th generation) in a one product. Compo-bonds have the benefits of self-etching dentin bonding agents and nano-filled resins. They eliminate the precursory bonding stage necessary to adhere, resin to tooth substrate, thus reducing the chances of postoperative sensitivity.[21] These composites have properties similar to the conventional flowable composites. They also have the properties of 7th generation of dentin bonding agents; thus, they act as shock absorbers beneath the resin-based composite restoration. As compo-bonds function both as dentin adhesive and resin restorative both as dentin adhesive and resin restorative material, a longer curing time is necessary to ensure that both constitutes are fully polymerized.[22]

Omnichrome

2019 marked the introduction of a number of products that would eventually change the trend of dentistry compared to the last two decades. 2019 brought the introduction of Omnichroma (Tokuyama Dental America). This was the first composite resin-based material that could match any tooth with any shade, on any patient. In the times where multiple shading of composite restoration is followed as the benchmark for restoring the tooth's anatomy, Omnichroma poses a unique property that allows clinicians to not be concerned by the multiple shades. This provides a quick, easy system that creates attractive and functionally esthetic restorations. Omnichroma[23].

Smart Chromatic Technology in Omnichroma was debuted by Tokuyama Dental America where the material uses uniformly sized spherical filler particles. Omnichroma fillers alter the light that is transmitted along the red-to-yellow area of the color spectrum, which allows matching the color of the patient's

adjacent teeth. It contains UDMA/TEGDMA monomers and 260nm silica and zirconia fillers.

The main characteristics of Omnichroma are superior polish ability, excellent handling, and ambient light effect resistance. Wear and abrasion properties; along with wear of the composite and opposing tooth structure are minimal. Omnichroma comes in a paste, which is more of an opaque-white before curing, thereby allowing the material to be more visible for clinicians while manipulating and placement.[24] The material is homogeneously blended with the surrounded tooth structure when application of light source during curing is carried out. In order to facilitate marginal borders to disappear, a chamfered margin is preferred. A single shade is only required to match most posterior and anterior teeth. In case of extensive Class III and Class IV restorations, a blocking agent (Omnichroma Blocker) is used by placing 0.5mm layer before placement of Omnichroma. This masks the inner part of the crown; especially in presence of any discoloration. The blocker's function is to reduce shade-matching interference.[25]

Recommendations of using Omnichroma

- Direct restorations in both anterior and posterior dentitions.
- Direct composite veneering.
- Closure of diastema or any interdental spacing.
- Porcelain and composite repair.

Giomers

Recently, a new category of hybrid aesthetic restorative material, which differs from both resin modified GICs and compomers has been introduced. It was Developed by Shofu.

Giomers are available in market as one paste from and theses are light polymerizing and require bonding agents for adhesion to tooth structure.[26]

Commercially available as Reactmer(shofu, Japan), Beautifil (Shofu, Japan) and Beautifil II (Shofu, Japan).

Beautifil II is a second generation giomer, claiming better optical properties than RMGIC.

Itincorporates, hybridization of GIC and composite by using a exclusive technology known as the prereacted glass ionomertechnology. The fluoroaluminosilicate glass when reacted with polyalkenoic acid to yield a static phase of GIC, this pre reacted glass is then mixed with the resin. The PRG technology can be of 2 types, depending on the amount of glass which is reacted

1. F- PRG = reaction of Full / entire glass
2. S- PRG = Surface of glass.

Main Advantages of Giomers are- Fluoride release, Fluoride recharging, Biocompatibility, Excellent bonding, Clinical stability, Smooth surface finish and esthetics

Compomers

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.compomers is a combination of work=d "comp" from composite "omer" from ionomer.
it has fluoride releasing capability of Glass ionomer cement and durability of composite.

Setting Reaction Occurs in 2 Stages

1. **Stage I-** In contrast to RMGIC, a typical composite resin network around filler particles forms on light activaon.
2. **Stage II-** Occurs over 2-3 months when the water from the saliva gets absorbed and initiates a slow acid base reaction with formation of hydro gels within the resin and low level fluoride release[22]. Advantages - Superior. working characteristics to

RMGIC, easy of use, Easily adapts to the tooth, Good esthetic.

Conclusion

Although, Composite resin have significantly improved compared with their predecessors, introduction of high-performance restorative materials is necessary for the success of dental treatment. However, new expanding resins, nanofiller technology, and improved bonding systems have the potential to reduce these problems. With high esthetics concern, the utilization of composite materials will continue to grow; and so will be the need, to combat the existing limitations of composites as a restorative material.

Because new restorative materials have had little clinical testing, it is difficult to make specific material recommendations for the esthetic restoration of carious teeth. Although fluoride-releasing materials have long been used successfully to restore carious teeth, little clinical documentation has been presented to support their use to inhibit recurrent caries, and their use as an effective esthetic restorative material.

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