ORIGINAL RESEARCH PAPER

Dental Science

RECENT ADVANCES IN COMPOSITE RESINS- A REVIEW

KEY WORDS: Nanocomposites, Smart Composites, Packable Composites, Compobonds,Self-Repairing Composites, Fibre Reinforced Composite

Dr Reshma Faras*	POST GRADUATE STUDENT, MDS, Dept Of Conservative Dentistry And Endodontics, Maratha Mandal Nathajirao G. Halgekar institute of dental sciences and research Centre, Belagavi. *Corresponding Author
Dr Madhu Pujar	MDS, PROFESSOR, Head Of The Department, Dept Of Conservative Dentistry And Endodontics, Maratha Mandal Nathajirao G. Halgekar institute of dental sciences and research Centre, Belagavi.
Dr. Abhipsha Lahiri	POST GRADUATE STUDENT, MDS, Dept Of Conservative Dentistry And Endodontics, Maratha Mandal Nathajirao G. Halgekar institute of dental sciences and research Centre, Belagavi.
Dr. Shruthi C Havaldar	POST GRADUATE STUDENT, MDS, Dept Of Conservative Dentistry And Endodontics, Maratha Mandal Nathajirao G. Halgekar institute of dental sciences and research Centre, Belagavi.
Dr. Siddhi A Shetye	POST GRADUATE STUDENT, MDS, Dept Of Conservative Dentistry And Endodontics, Maratha Mandal Nathajirao G. Halgekar institute of dental sciences and research Centre, Belagavi.

ABSTRACT

The increasing demand for improving the esthetics and restoration performance led to the introduction of resin based dental materials , that was a revolution in restorative dentistry. These resin composites were not just aesthetically more pleasing but it also reinforced the tooth as it conserves more tooth structure in preparation design. But, the early formulations of these resin composite materials had numerous drawbacks such as poor handling characteristics and polymerization shrinkage. Therefore, there was a need to improve its properties that led to the development of its advances. Thus the aim of this review is to discuss the recent advances in composite resins.

INTRODUCTION

There has always been a quest in dentistry to enhance the esthetics of teeth. The aim of restorative and esthetic dentistry is to replace lost or damaged structures with artificial materials that possess physical ,biological and functional properties similar to that of the natural teeth .This constant desire of dental profession to achieve a natural appearance, has led to development of various tooth coloured material, one among them being dental composites. Composite resins are complex, tooth-colored filling materials that offer excellent esthetic potential and acceptable longevity without the need for extensive tooth preparation, allowing minimally invasive preparation or sometimes no preparation at all. They represent one of the many successes of modern biomaterial research.

But, however after their introduction these composite resin have shown certain drawbacks such as high polymerization shrinkage, low wear resistance, high coefficient of thermal expansion etc, that has led to their clinical failures.Thus to overcome these shortcomings, newer composite materials were developed with low polymerization shrinkage, better handling properties and improved clinical performance.

NANOCOMPOSITES:

Nanotechnology consists of reducing components of a material to the nanometric scale for use in a new material to improve the final characteristics. In nanofilled composite resins, the inorganic nanofillers are added to organic matrix to have the strength of inorganic material and flexibility and toughness of organic material.These composite resins have approximately 60% volume filler loading, making the nanofilled resins as strong as the hybrid and micro hybrid resins.The nanocomposite have nanofillers that contain nano-modifier such as the nanomers and nanoclusters that result in increased flexural strength ,increased modulus of elasticity,increased wear resistance & hardness, decrease polymerisation shrinkage ,absorb and dissipate loading stresses to provide enhanced damage tolerance and enhance the polishability of resin.

PACKABLE OR CONDENSABLE COMPOSITES OR POLYMERIC RIGID INORGANIC MATRIX MATERIAL(PRIMM)

It is one of the new advances in posterior composites. This new concept was developed by Dr. Lars Ehrnford of Sweden. In this variant of composite, rather than incorporating the filler particles into the composite resin matrix, he devised a unique system by which the resin is incorporated into the fibrous ceramic filler network. This inorganic ceramic component is composed of a continuous network or scaffold of ceramic fibers-alumina and silica dioxide fibers instead of ground filler. This new concept has resulted in advantages like greater wear resistance, better marginal adaptation, increased flexural strength, high modulus of elasticity, reduced polymerization shrinkage, high curing depth (cured upto depth of 6mm due to light conducting properties of individual ceramic fibres) and viscosity similar to that of amalgam.

SELF HEALING OR SELF-REPAIRING COMPOSITES

Materials usually have a limited lifetime and degrade in the course of time due to different physical, chemical or biological stimuli. But, researchers have developed materials which can repair by themselves. The self healing or self repairing material is an epoxy system which contains resin filled microcapsules. If a crack occurs in the epoxy composite material, some of the microcapsules are destroyed near the crack and release the resin. The resin subsequently fills the crack and reacts with a Grubbs catalyst dispersed in the epoxy composite , resulting in a polymerization of the resin and repair of the crack.

STIMULI RESPONSE MATERIALS / SMART COMPOSITES

Stimuli responsive materials also called smart materials, possess properties that may be considerably changed in a controlled fashion by external stimuli. Such stimuli may be, change in temperature, mechanical stress, pH or moisture. These smart composites are also called as intelligent composites. This composite resin material releases fluoride, calcium and hydroxyl ions into the surroundings of the filling. The release of these ions depends on the pH value. When the pH value in the oral cavity is low (<5.5) due to active plaque, it releases significantly higher amounts of ions than it does at neutral pH, thus providing additional caries protection. Thus, these stimuli responsive dental composites may be useful to fight microbes or secondary caries respectively.

SELF-ADHERING COMPOSITES OR COMPOBONDS

First compobond was introduced in 2009 by (Kerr Corp., USA) .They are termed as Self-adhering composites. Compobonds exploit the benefits of self etching dentin bonding agents and nanofilled resins, eliminating the precursory bonding stage necessary to adhere a resin to tooth substrate thus reducing the chances of post operative sensitivity. It is a light-cured composite with similar properties to conventional flowables. It incorporates the properties of the 7th generation dentin bonding agent that acts as a shock absorber beneath resin-based composite restorations. Self-adhering flowable composites are to be used in increments. The first increment in intimate contact with the tooth surface should be 1 mm. This increment has to be agitated to condition the tooth for 20's prior to light curing. Additional material can then be syringed in increments of 1.5–2 mm and light cured. Because Compobonds function both as a dentine adhesive and a resin restorative material, a longer curing time is necessary to ensure that both constituents are fully polymerised.

FIBRE REINFORCED COMPOSITE

These composites consist of different types of fiber reinforcement materials such as carbon, glass, ultra-high-molecular-weight polyethylene (UHMWPE) and silane-treated glass.Currently, the most popular fiber types are UHMWPE and glass. These fibres are incorporated into the resin to reinforce dental composite. Stresses on the matrix are transmitted to fibers. The Geometrical arrangement of fibers are available as (Wave, Braided, Unidirectional, Mesh).Orientation of fibres is found to have a significant effect on direction of shrinkage strain. These fiber reinforced composites have shown improved strength and stiffness and improved wear resistance. Their main applications are in periodontal splinting/ post trauma splint, fixed partial dentures, reinforcing or repairing dentures, fixed orthodontic retainers, root posts and reinforced biomedical implants.

INDIRECT COMPOSITE RESIN

To overcome the problems the clinicians experienced with direct composites, indirect composites were introduced. They were introduced to reduce polymerization shrinkage and improve the properties of material like wear resistance, aesthetics and marginal adaptation. The indirect composite resin is based on first and second generations. Touati and Mormann introduced the first generation of indirect resin composites (IRCs). The first generation indirect composite resins had a composition identical to that of the direct resins.It was observed that the first-generation indirect composite resins showed improved properties only in laboratory studies, but had failures in clinical studies. This led to the development of improved second generation composites . The second-generation composites have a 'microhybrid' filler with a diameter of 0.04-1 µm, which is in contrast to that of the first-generation composites that were microfilled. The filler content is twice that of the organic matrix. By increasing the filler load, the mechanical properties and wear resistance is improved and by reducing the organic resin matrix, the polymerization shrinkage is reduced .

CONCLUSION:

It is apparent that the science and technology of composites have significantly improved compared with their predecessors. Although composites have not evolved to the point of totally replacing amalgam, they have become a viable substitute for amalgam in many clinical situations. As we know the development of high performance restorative materials is essential to the success of dental treatment but with composite resin materials, problems still exist . However, new expanding resins, nanofiller technology and improved bonding systems have the potential to reduce these problems. With increased patient demands for esthetics, the use of composite materials for restorations will continue to grow; and so will the area of research in order to combat the existing limitations of composites as a restorative material.

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