P.Benly et al /J. Pharm. Sci. & Res. Vol. 8(8), 2016, 881-883

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Recent Advances in Composite – A Review

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Abstract:
The aim of the review is to enhance the recent advances in composite. Composite dental restorations represent a unique class of biomaterials with severe restrictions on biocompatibility, curing behaviour, aesthetics, and ultimate material properties. Composite restorative materials represent one of the many successes of modern biomaterials research, since they replace biological tissue in both appearance and function. The development and implementation of composite dental restorative materials rely on a comprehensive understanding of each component of the composite and consideration of methods for changing each component. These materials have been the focus of a great deal of research in recent years with the goal of improving restoration performance by changing the initiation system, monomers, and fillers and their coupling agents, and by developing novel polymerization strategies.

Keywords: Unique biomaterial, polymerization shrinkage, nanocomposite

INTRODUCTION:

Composite resins have been introduced into the field of conservative dentistry to minimize the drawbacks of the acrylic resins that replaced silicate cement in the 1940s. 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 [1]. The development and implementation of composite dental restorative materials rely on a comprehensive understanding of each component of the composite and consideration of methods for changing each component [1]. The purpose of this article is to discuss new resin systems exhibiting substantial improvements in wear resistance and clinical performance [2].

COMPOSITE:

Composites are composed of three distinct phases, each with its own role in dictating material properties: the polymerizable resin, filler, and the filler-resin interface. The resin phase is composed of polymerizable monomers that convert from a liquid to a highly cross linked polymer upon exposure to visible light, which catalyzes the formation of active centres, typically radicals that induce polymerization [2]. The filler has several roles, including enhancing modulus, radiopacity, altering thermal expansion behaviour, and reducing polymerization shrinkage by reducing the resin fraction. Finally, the filler-resin interface serves as a bridge by coupling polymerizable moieties to the particle surface. Each component represents an opportunity for improvements in the overall composite and is the target of recent research reviewed here [3].composite resins are types of synthetic resins which are used in dentistry as restorative material or adhesives. Synthetic resins evolved as restorative materials since they were insoluble, aesthetic, insensitive to dehydration, easy to manipulate and reasonably inexpensive [2]. Composite resins are most commonly composed of Bis-GMA and other dimethacrylate monomers (TEGMA, UDMA, and HDDMA), a filler material such as silica and in most current applications, a photoinitiator. Dimethylglyoxime is also commonly added to achieve certain physical properties such as flow ability [3].

DIRECT COMPOSITE RESIN:

This concept was developed by Dr. Lars Ehrnford of Sweden. This mainly consists of aluminum oxide and silicon dioxide glass particles or barium aluminum silicate or strontium glasses. The glass particles are liquefied to form a molten glass which is forced through a die to form thin strands of glass fibers [4]. Traditional light-cured hybrid resin composites cannot be bulk placed because of excessive polymerization shrinkage and the inability to adequately light-polymerize the resin beyond a 2 mm depth [5]. Bulk placement of packable composites was claiming decreased polymerization shrinkage due to increased filler loading and a reported depth of cure reaching 5 mm [4]. Packable resin composites were developed to restore surfaces that previous resin composites could not. Avoiding saliva and blood contamination of the prepared enamel and dentin surfaces is vital to achieve a proper bond. Packable resin composite should not be viewed as a time saver as bulk placement of packable resin composite is not recommended and may compromise the long-term success of the restoration [5].

FLOWABLE COMPOSITE:

It is termed as “flowable composite” because of its low viscosity and ability to be syringed into a cavity preparation with a needle tip. Most of the flowable composites presently available are not filled, generally containing from 56% to 70% filler by weight. Accordingly, they have reduced mechanical properties such as a higher susceptibility to wear, a higher polymerization shrinkage, and lower flexural strength [6]. Flowable composite resin materials can be useful not only as a liner but to build up cavity preps, to block out small undercuts and to use as an indirect or direct pulp cap. Low modulus flowable resin composites have been described as potentially radiopaque “filled adhesives” with implications for improved clinical dentin bonding [7]. Flowable composites are used under composites restorations as stress breaker so as to compensate for polymerization shrinkage stress of over lying composite resin, repair of composite resin restorations

INDIRECT COMPOSITE RESIN:

The indirect composite resin is based on first and second generations. A number of highly improved indirect resin restorative systems have been introduced with unusually good properties like wear resistance, aesthetics, marginal adaptation, and control over polymerization shrinkage [8]. Touati and Mörmann introduced the first generation of indirect resin composites (IRCs). The first generation IRCs had a composition identical to that of the direct resin composite. The clinical failures endured with the first generation composites and the limitations faced with ceramic restorations led to the development of improved second generation composites [9]. The second generation composites have"microhybrid" filler with a diameter of 0.04-1 μ, which is in contrast to that of the first generation composites that were micro filled. 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 [9].

NANOCOMPOSITES:

Nanotechnology may provide composite resins with a dramatically smaller filler particle size that can be dissolved in higher concentrations and polymerized into the resin system [10]. Nanoparticle filled composites exhibit outstanding aesthetics, are easy to polish and posses an enhanced wear resistance. 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. Nanocomposites show greater fracture toughness and adhesion to tooth structure [11].

ANTIMICROBIAL COMPOSITE:

Antimicrobial properties of composites may be accomplished by introducing agents such as silver or one or more antibiotics into the material. Silver and titanium particles were introduced into dental composites, respectively, to introduce antimicrobial properties and enhance the biocompatibility of the composites [12]. The antibacterial properties of these composites were based on contact mechanism rather than on leaching. The antimicrobial effect lasted for at least 1 month [13].

STIMULI RESPONSIVE COMPOSITE:

Stimuli-responsive materials possess properties that may be considerably changed in a controlled fashion by external stimuli. Such stimuli may be for example changes of temperature, mechanical stress, pH, moisture, or electric or magnetic fields [14]. These composites may be very effective against secondary caries. They are used for treating the secondary caries in the posterior teeth region.

FIBRE REINFORCED COMPOSITE:

Fiber-reinforced composites have numerous industrial and aerospace applications because they are light, strong and non-flammable. However, with respect to clinical dentistry, they are relative newcomers into the spectrum of prosthodontic treatment options [15]. The main advantage of these fibre reinforced composite was they can be used in both direct and indirect restorations [15].

SELF HEALING COMPOSITE:

Materials usually have a limited lifetime and degrade due to different physical, chemical, and biological stimuli. These may include external static (creep) or dynamic (fatigue) forces, internal stress states, corrosion, dissolution, erosion, or biodegradation. This gradually leads to a deterioration of the material structure and finally failure of the material. One of the first self-repairing or self-healing synthetic materials reported interestingly shows some similarities to resin-based dental material; it was the epoxy resin composite [16]. 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 [17].

CONCLUSION:

The use of composites is increasing because of its benefits from adhesive bonding to tooth structure, aesthetic qualities and universal clinical usage. When done properly, a composite restoration can provide excellent service for years. A new quality of dental composites may, however, be created if nanotechnology is used and other new developments in material science and biomaterials are considered in composites in the future. The development of high performance restorative materials is essential to the success of dental treatment. It must be noted that in addition to the restorative material, other aspects are important for success. The future promises to be exciting with substantial progress in the development of adhesive, wear resistant dental polymers.

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