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Review

Polyacid-modified composite resins ("compomers") and their use in clinical dentistry

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ABSTRACT

Objectives. This paper describes the chemistry and properties of polyacid-modified composite resins ("compomers") designed for use in clinical dentistry, and reviews the literature in this area.

Methods. Information has been obtained from over 50 published articles appearing in the dental and biomaterials literature, with studies being principally identified through MedLine.

Results. Published work shows that polyacid-modified composite resins constitute a discrete class of polymeric repair material for use in dentistry. Their distinction is that they contain hydrophilic components, and these cause water to be drawn into the material following cure. This triggers an acid–base reaction, and gives the materials certain clinically-desirable properties (fluoride release, buffering capability) that are also associated with glass-ionomer cements. The water uptake leads to a decline in certain, though not all, physical properties. However, clinical studies have shown these materials to perform acceptably in a variety of applications (Class I, Class II and Class V cavities, as fissure sealants and as orthodontic band cements), especially in children's teeth.

Conclusions/significance. Polyacid-modified composite resins constitute a versatile class of dental repair material, whose bioactivity confers clinical advantages, and which are particularly useful in children's dentistry.

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1. Definition and distinctiveness

Polyacid-modified composite resins, known trivially as compomers, are a group of aesthetic materials for the restoration of teeth damaged by dental caries [1]. They were introduced to the profession in the early 1990s [2], and were presented as a new class of dental material designed to combine the aesthetics of traditional composite resins with the fluoride release and adhesion of glass-ionomer cements. The trivial name was devised from the names of these two “parent” materials, the “comp” coming from composite, and “omer” from ionomer [3].

The term *polyacid-modified composite resin* was originally proposed for these materials in 1994 [1] and has been widely adopted both by manufacturers and researchers since that time. However, it has been criticised on the grounds that it “...may over-emphasize a structural characteristic of no or little consequence” [3]. This is a somewhat strange criticism, since to formulate these materials, manufacturers have modified them specifically by the introduction of acid-functional macro-monomers. They are, therefore, without question “polyacid modified”. Whether this modification confers clinical benefits, or indeed whether these materials can usefully be considered to be distinctive materials is more debateable. The conclusion of Ruse is that “... They are, after all, just another dental composite” [3], but this seems to the present author to be somewhat extreme, and there is considerable evidence that compomers possess characteristic properties, and are therefore distinct from conventional composite resins.

Nonetheless, polyacid-modified composite resins have been studied widely, both in terms of their materials science and their clinical applications. After more than a decade of research and clinical use, it is therefore timely to review their status. This paper does that, and has involved a comprehensive search of the literature using Medline®. It is not, however, merely a catalogue of publications, but is a critical review, based on the author’s many years of research on these materials.

2. Composition and setting

As has already been stated, compomers resemble traditional composite resins in that their setting reaction is an addition polymerization [2]. It is usually light-initiated, and the initiator is camphorquinone with amine accelerator, and as such is sensitive to blue light at 470 nm [2]. There is, however, at least one brand, designed for use as luting cement, Dyract Cem, that is a two-paste system [4]. Cure is brought about as a result of mixing the two pastes, each of which contains a component of the free radical initiator system. The set material, though, does not differ in any fundamental way from those compomers that cure photochemically.

A key feature of compomers is that they contain no water and the majority of components are the same as for composite resins. Typically these are bulky macro-monomers, such as bisglycidyl ether dimethacrylate (bisGMA) or its derivatives and/or urethane dimethacrylate, which are blended with viscosity-reducing diluents, such as triethylene glycol dimethacrylate (TEGDMA). These polymer systems are filled with non-reactive inorganic powders, such as quartz or a silicate glass, for example $SrAlFSiO_4$ [5]. These powders are coated with a silane to promote bonding between the filler and the matrix in the set material [3]. In addition, compomers contain additional monomers that differ from those in conventional composites, which contain acidic functional groups. The most widely used monomer of this type is so-called TCB, which is a di-ester of 2-hydroxyethyl methacrylate with butane tetracarboxylic acid [5]. This acid-functional monomer is very much a minor component and compomers also contain some reactive glass powder of the type used in glass-ionomer cements [1].

Despite the presence of these additional components, compomers are similar to composite resins in that they are fundamentally hydrophobic, though less so than conventional composite resins. They set by a polymerization reaction, and only once set do the minority hydrophilic constituents draw in a limited amount of water to promote a secondary neutralization reaction [5]. They lack the ability to bond to tooth tissues [6,7], so require bespoke bonding agents of the type used with conventional composite resins [7], and their fluoride release levels are significantly lower than those of glass-ionomer cements [8,9]. Such low levels of fluoride release have been shown to compromise the degree of protection afforded by these materials in *in vitro* experiments using an artificial caries medium [10].

Polymerization in light-cured compomers has been studied using FTIR [3,11], as has the secondary neutralization process [3,11,12]. The polymerization was followed by studying the rate of disappearance of the peaks at 1700–1730, 1630 and 1230–1320 cm^{-1}, all of which are associated with C=C double bonds [3,11]. It was found that these peaks disappeared rapidly on exposure to light, so that reaction had proceeded to a substantial extent by 150 s. Despite this, the degree of conversion was only of the order of 50% or less after this time [11]. Polymerization was found to continue after the light was switched off, though at a slower rate, and to proceed for up to 60 h post-irradiation. This phase of the degree of polymerization, x, could be described by an equation of the form:

$$x = A + B \ln t$$

where t is the time. For the material Dyract AP, values were $A = 27.7 \pm 0.3\%$ and $B = 2.15 \pm 0.01\%$, whereas for Compoglass F, $A = 40.3 \pm 0.1\%$ and $B = 1.98 \pm 0.08\%$ [11]. Depth of light penetration was found to be low, due to a combination of absorption by initiator molecules higher up in the specimen, and light

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