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Two year clinical evaluation of a low-shrink resin composite material in UK general dental practices

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ABSTRACT

Objective. A novel resin composite system, Filtek Silorane (3M ESPE) with reduced polymerization shrinkage has recently been introduced. The resin contains an oxygen-containing ring molecule ('oxirane') and cures via a cationic ring-opening reaction rather than a linear chain reaction associated with conventional methacrylates and results in a volumetric shrinkage of ~1%. The purpose of this study was to review the literature on a recently introduced resin composite material, Filtek Silorane, and evaluate the clinical outcome of restorations formed in this material.

Methods. Filtek Silorane restorations were placed where indicated in loadbearing situations in the posterior teeth of patients attending five UK dental practices. These were evaluated, after two years, using modified USPHS criteria.

Results. A total of 100 restorations, of mean age 25.7 months, in 64 patients, were examined, comprised of 30 Class I and 70 Class II. All restorations were found to be present and intact, there was no secondary caries. Ninety-seven per cent of the restorations were rated optimal for anatomic form, 84% were rated optimal for marginal integrity, 77% were rated optimal for marginal discoloration, 99% were rated optimal for color match, and 93%% of the restorations were rated optimal for surface quality. No restoration was awarded a "fail" grade. No staining of the restoration surfaces was recorded and no patients complained of post-operative sensitivity.

Significance. It is concluded that, within the limitations of the study, the two year assessment of 100 restorations placed in Filtek Silorane has indicated satisfactory clinical performance.

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1. Introduction and literature review

1.1. *Practice-based research*

A majority of research into the effectiveness of dental materials is carried out in dental hospitals or other academic institutions, rather than in general dental practice, even though the latter is where the majority of dental treatment is performed, worldwide. Reasons for this divergence include the potential cost, given that practices are geared to the efficient treatment of patients rather than research and a perception that the training of general practitioners in research methods may be incomplete. However, there are many reasons why dental practice increasingly should become the prime location for clinical dental research. Dental practice is the real world, better representing the day-to-day handling, placement and service life of resin composites. The importance of practice-based research has been emphasized by Mandel, who considered that "research is not only the silent partner in dental practice, it is the very scaffolding on which we build and sustain a practice" [1]. An advantage for the practitioner is the benefit of being involved in something not normally within the daily routine of practice, and that patients have been found to approve of practitioner involvement in research, with the practice and practitioner's professional image being enhanced [2].

The performance of a restorative material by one operator is necessarily subjective, but when practitioners band together to form a group in order to evaluate new materials in dental practice, the results are likely to be more objective. All of this is possible when practitioner-based research groups are teamed with the expertise available in academic institutions. Perhaps the most well known group of practice-based researchers is the **C**linical **R**esearch **A**ssociates (CRA) founded by Gordon Christensen in Utah, USA over thirty years ago. A UK-based group of practice-based researchers is the PREP (**P**roduct **R**esearch and **E**valuation by **P**ractitioners) Panel. This group was established in 1993 with 6 general dental practitioners, and has grown to contain 33 dental practitioners located across the UK and one in mainland Europe. It has completed over 50 projects—"handling" evaluations of materials and techniques, and more recently, clinical evaluations ($n = 9$) of restorations at one year and up to five years. This paper describes the early performance of a novel resin composite restorative material, Filtek Silorane (3M ESPE, Seefeld, Germany), when placed in loadbearing situations in posterior teeth of patients attending the practices of five members of the PREP Panel.

1.2. *Resin composite restorations and polymerization contraction stresses*

The majority of conventional resin composite restorative materials shrink up to 3% on polymerization, resulting in stresses at the (bonded) restoration margin, or within the restorative material itself [3], with the clinical result of these stresses being [3]:

- Internal microcracks within the bulk of the material.
- Separation of the bonding agent from the cavity wall, with resultant marginal leakage and post-operative sensitivity.
- Enamel microcracks, with a resultant white line adjacent to, or at a distance from the restoration.
- Deformation of tooth, also leading to pain post-operatively, generally when the patient bites on a cusp.

Shrinkage stress is not an intrinsic material property and the magnitude of the stresses depends on a number of factors, including properties that are intrinsic to the material, such as:

- volumetric shrinkage,
- the modulus of elasticity,
- the degree of cure (polymer conversion),
- the coefficient of thermal expansion,
- silanization characteristics at the resin-filler interface,

and clinically oriented factors such as:

- the rate of cure and polymerization kinetics,
- the configuration of the cavity into which the restoration is placed,
- compliance of the remaining tooth structure.

In this respect, it has recently been demonstrated that it is in larger, rather than smaller, Class I cavities that the effect of the so-called configuration factor may be most relevant [4].

A number of clinical techniques have been suggested to reduce or overcome the effect of polymerization contraction stresses. Table 1 [5–8] presents some of the techniques which have been advocated for minimizing stress. The benefits of certain techniques such as "soft-start" or "ramped" curing, or the use of flowable resin composites is debated in the literature. The former method may lead to decreased structural integrity and, depending on material formulations, the latter may increase polymerization shrinkage compared with conventional techniques.

Table 1 – Clinical techniques which have been suggested to reduce or overcome the effect of polymerization contraction stresses.

• Incremental placement, with one increment touching only one wall of the cavity, and, limiting the size of the increments
• Ramped curing, in which the curing light does not reach its maximum intensity for up to 20 s
• Pulse activation, in which the resin composite material is cured for 5 s and then left for up to 5 min [5]
• Use of macro-fillers to reduce resin volume: however, this has not been shown to improve clinical effectiveness [6]
• Placement of a flowable composite base layer which has been shown to reduce microleakage at the gingival margin in Class II cavities in a number of *in vitro* experiments [7,8]
• Use of a chemically cured composite or glass ionomer base

It could also be considered that some or all of these additional stages lead to increased technique sensitivity during placement of resin composite restorations, and indeed, that these stages, which are designed to reduce polymerization contraction stress, could be a source of operator stress! The use of a resin with reduced polymerization shrinkage, with a