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Effect of Opalescence® bleaching gels on the elution of bulk-fill composite components

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ABSTRACT

Objectives. Bleaching treatments can affect release of components from conventional composites. In this continuing study the influence of two different bleaching gels on the elution of bulk-fill composite components was investigated.

Methods. The composites Tetric EvoCeram® Bulk Fill, QuiXFil™ and X-tra fil were treated with the bleaching gels Opalescence PF 15% (PF 15%) for 5 h and PF 35% (PF 35%) for 30 min and then stored in methanol and water for 24 h and 7d. The eluates were analyzed by gas chromatography/mass spectrometry (GC/MS). Unbleached specimens were used as control group.

Results. A total of 7 different elutable substances have been identified from the investigated composites after bleaching-treatment. Three of them were methacrylates: 2-hydroxyethyl methacrylate (HEMA), triethylene glycol dimethacrylate (TEGDMA) and trimethylolpropane trimethacrylate (TMPTMA). Compared to the unbleached controls an increase in elution after PF 15%-treatment of following compounds was found: HEMA (Tetric EvoCeram® Bulk Fill), TEGDMA (QuiXFil™, X-tra fil) and 4-N,N-dimethylaminobenzoic acid butyl ethoxy ester (DMABEE) (Tetric EvoCeram® Bulk Fill, QuiXFil™, X-tra fil). Following compounds showed a reduction in elution after PF 35%-treatment compared to controls: TEGDMA (QuiXFil™) and DMABEE (Tetric EvoCeram® Bulk Fill). The highest concentration of HEMA was 0.22 mmol/l (Tetric EvoCeram® Bulk Fill, methanol, 7d, PF 15%), the highest concentration of TEGDMA was

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0.3 mmol/l (X-tra fil, water, 7d, PF 15%) and the highest concentration of DMABEE was 0.05 mmol/l (QuiXFil™, water, 7d, PF 35%).

Significance. PF 15% and PF 35% can lead to reduced and/or increased elution of some bulk-fill components, compared to unbleached bulk-fill composites.

1. Introduction

The aesthetic demands on our society are continuously growing. White teeth are also a crucial factor for an appealing appearance. In addition to veneers and tooth-colored crowns, for example, bleaching the teeth is the most common procedure to aesthetically enhance them [1]. For this purpose, there are four different methods which work with carbamide and/or hydrogen peroxide gel. (1) In-office bleaching methods (35% peroxides), (2) chairside-bleaching methods (38% peroxides) [2], (3) home-bleaching methods (15% peroxides) [3] and (4) over-the-counter products (maximum 10% peroxides). In order to apply the bleaching gel, bleaching trays are only used for the home-bleaching method and the in-office bleaching method [4]. Carbamide peroxide decomposes during the bleaching process upon contact with saliva in hydrogen peroxide and urea, which in turn decomposes into ammonia and carbon dioxide. Hydrogen peroxide, disassociates into oxygen and water [5,6]. However, both in the chairside- and in the in-office bleaching method, hypersensitivity in the teeth [7] and damage to the pulp cells [8] can be noted due to the use of high-percentage (38% or 35%) carbamide or hydrogen peroxide gels. Through a reduction in the percentage content of the bleaching gel, as in the home bleaching methods (15% peroxides), a reduction in the hypersensitivities can be achieved [9].

However, if insufficient restorations are detected in a patient before a bleaching process, they must be swapped out in each case before starting the bleaching process because damage to the pulp cells can be caused upon contact of the bleaching gels with the pulp [10]. For this purpose, different composite materials are taken into account such as bulk-fill or other conventional composites. The latter are used in the incremental technique, i.e. integrated into maximum 2 mm thick layers [11], to ensure, according to the manufacturer, the complete polymerization of the composite. On the other hand, bulk-fill composites guarantee a sufficient polymerization depth at increments up to 4 mm strength [12], which can be attributed to an increased translucence through reduced filling material content with simultaneously increased filling particle size [13]. The aforementioned properties allow a quick one-incremental technique to fill a complete cavity for bulk-fill composites in many cases [14].

Studies have already been performed on the mechanical properties of bulk-fill composites [14–16]. Thus, for example, for cuspal deflection [17], the marginal integrity of a filling [11,18], just as for its cure depth [11] better results of bulk-fill composites compared to composites which are added in the incremental technique were detected. However, also adverse results were found compared to conventional composites such as the conversion rate, for bulk-fill composites [19]. At >55%, conversion rate for bulk-fill composites is still in the clinically acceptable range but it is still less than for conventional composites [19].

In the past, some composite materials were already studied in terms of their reaction to a bleaching process. For example, changes in terms of surface structure [6,20,21] and microhardness [22,23] are tested. In our own studies it could be shown that the bleaching processes also affect the release of monomers (methacrylates) and other components from dental composites [24–27]. In addition to initiators, stabilizers, additives and pigments, monomers (methacrylates) are also components of the organic resin matrix of non-polymerized composites [28]. However, polymerization of dental composites is incomplete. The lower the conversion rate of a composite, the more residual monomers can be eluted [29]. These elutable monomers (methacrylates) can result in allergic reactions [30], such as asthma, allergic rhinoconjunctivitis or contact dermatitis [31].

In our own earlier studies [24–27], the effect of the bleaching gels Opalescence® PF 15% (PF 15%) and Opalescence® PF 35% (PF 35%) on the release of components from conventional composites was investigated. The aim of this continuing study is the investigation of the effect of PF 15% and PF 35% on the time-dependent elution of composite components from various bulk-fill composites.

In the null hypothesis, it is assumed that PF 15% and PF 35% have no effect on the release of components from bulk-fill composites compared to the release of components without PF 15% or PF 35% treatment.

2. Materials and methods

The tested composites including manufacturers' data and the bleaching gels are listed in Tables 1 and 2.

2.1. *Preparation of samples*

The preparation of samples as well as the bleaching treatment has been performed according to our earlier study [27]. Composites (Table 1) were polymerized and bleached (Table 2) exactly according to instruction of manufacturer. For each composite (Table 1) 3 groups with 4 samples each ($n = 4$) were prepared: 1. samples bleached with PF 15% for 5 h; 2. samples bleached with PF 35% for 30 min and 3. unbleached samples: Control group. QuiXFil™ and X-tra fil were used in universal shade and Tetric EvoCeram® Bulk Fill in IVA (universal A-shade).

Subsequently samples were incubated in brown glass vails (Macherey-Nagel, Düren, Germany) with 1 ml of methanol (GC Ultra Grade, RATISOLV® ≥ 99.9%, Roth, Karlsruhe, Germany) at

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