Available online at www.sciencedirect.com

ScienceDirect

Tanta Dental Journal 12 (2015) 71–80

www.elsevier.com/locate/tdj

Degree of conversion and surface hardness of bulk-fill composite versus incremental-fill composite

Y.A. Abed [a,*], H.A. Sabry [b,1], N.A. Alrobeigy [c,2]

[a] *Department of Operative Dentistry, Faculty of Dentistry, October 6 University, Egypt*
[b] *Department of Dental Biomaterials, Faculty of Dentistry, October 6 University, Egypt*
[c] *Department of Dental Biomaterials, Faculty of Dentistry, Tanta University, Egypt*

Received 25 November 2014; revised 27 December 2014; accepted 8 January 2015
Available online 9 March 2015

Abstract

Objective: The aim of this study was to evaluate the degree of conversion and surface hardness of two bulk-fill composites and one incremental-fill composite.
Methods: Bulk-fill composites (x-tra fil, Voco; QuiXfil, Dentsply) and incremental-fill composite (Grandio, Voco) were used. Twenty five cylindrical specimens (5×4 mm) were made from each material in Teflon molds. Mold was filled in one increment for the bulk-fill composites and in two increments for the incremental-fill composite. Specimens were stored dry in dark at room temperature for 24 h before testing. Degree of conversion (DC) was determined using Fourier transform infrared spectroscopy (FTIR). A microhardness tester was used to measure the Vickers hardness number (VHN) on top and bottom surfaces of each specimen. Data for DC and VHN were analyzed by ANOVA and pair-wise Newman–keuls test.
Results: X-tra fill recorded significantly the highest DC, while no significant difference was noted between the other two composites. The VHN mean values of all composites tested were significantly different from each other ($P < 0.0001$), either in top or bottom surface, with Grandio showed the highest mean value and QuiXfil showed the lowest mean value. Only QuiXfil recorded no significant VHN difference between its top and bottom surfaces. There was no significant difference in bottom/top hardness ratio% among materials. Non significant Correlation between VHN and DC was noted.
Conclusions: X-tra fil showed the most DC performance. Incremental-fill composite showed higher VHN than bulk-fill composites. Differences in DC and VHN values among materials proved to be a material dependent.

Keywords: Bulk-fill composite; X-tra fil; Grandio; QuiXfil; Degree of conversion; Surface microhardness

1. Introduction

Resin-based composites have been successfully used in dentistry for many years and widely replaced amalgam as a posterior restorations [1]. Dental composites are expected to have mechanical properties comparable to those of tooth enamel and dentin and

* Corresponding author. Tel.: +20 1228803080.
E-mail addresses: yaser_abbed@yahoo.com (Y.A. Abed), hadentist@hotmail.com (H.A. Sabry), nalrobigy@yahoo.com (N.A. Alrobeigy).
Peer review under the responsibility of the Faculty of Dentistry, Tanta University
[1] Tel.: +20 1001612263.
[2] Tel.: +96 6509816900.

http://dx.doi.org/10.1016/j.tdj.2015.01.003
1687-8574/© 2015, Hosting by Elsevier B.V. on behalf of the Faculty of Dentistry, Tanta University.

provide a long life of service [2,3]. However, several factors limit the performance of composites, especially depth of cure and degree of conversion (DC) [2,4–6].

In spite of great advances in resin based composite technologies, an insufficient depth of cure is one of its major disadvantages [7]. Due to insufficient depth of cure, incremental placement technique, with a maximum 2 mm thickness, was used for large composite restorations, especially class II restorations [8]. However, the use of dental composite in an incremental placement technique, and light curing each increment individually is time consuming for the patient and the operator [9]. There is also an increase possibility of air bubble inclusion or moisture contamination between individual increments of resin composite restorations [10].

Recently, a new class of resin-based composite, the so-called "bulk-fill" composites have been introduced into the dental market with the purpose of time and thus cost savings [9]. The unique advantage of this new material class is stated that it can be placed in a 4 mm thickness bulks to be cured in one step instead of the current incremental placement technique, without adverse effect on polymerization shrinkage, cavity adaptation, or degree of conversion. Furthermore, the manufacturers stated that the polymerization shrinkage of those materials is even less than that of commonly used flowable and conventional resin-based composites [11]. Consequently, problems arise from polymerization shrinkage could be reduced [12]. This new material class includes flowable and high viscosity (paste) material types.

Adequate polymerization transforms the monomers into a complex polymer structure. Monomer conversion into polymers does not attain 100%, but results in monomers that remain unreacted. Resin composites start the polymerization process by absorbing light in a specific range of wavelength around 400–500 nm; once activated, react with the aliphatic amine to produce free radicals. The number of double carbon links (C=C) present in the monomers, which are converted into single links (C–C) to form the polymer chains during the polymerization process, is called degree of conversion [13,14].

For achieving long-term durability of dental composites, it is important that most of their monomers converted into polymers during polymerization reaction. Unfortunately, the dimethacrylate polymer exhibit considerable unsaturated monomers in the final product [15–18].

There are several contributing factors that can influence the DC such as light source used [18], power density [6], wavelength [19], irradiation time [4], light-tip size [6], photo-activation method [20], chemistry of organic matrix formulations [15–17], distribution and quantity of inorganic fillers [21], the type and quantity of the photo-initiator [22], and color of the composite resins [9].

The Physical and mechanical properties of dental composites are directly influenced by the degree of conversion achieved during polymerization [23]. Lower degree of conversion provides composites with an inferior mechanical properties and greater discoloration and degradation [24] and as a result, restorations with poor wear resistance and poor color stability [25].

In the study of Tiba et al. [26], multiple bulk-fill (flowable and high viscosity) and incremental-fill resin composites were evaluated regarding depth of cure to be acceptable according to international standard 4049 [27]. Three of the high viscosity bulk-fill resin composites (SonicFill, Kerr; Tetric EvoCeram Bulk Fill, Ivoclar-Vivadent; Alert Condensable Composite, Pentron), one flowable bulk-fill composite (Filtek Bulk Fill Flowable Restorative, 3M ESPE), and one incremental-fill composite (Heliomoler HB, Ivoclar-Vivadent) did not achieve adequate depth of cure according to the standard. However all other materials tested either high viscosity bulk-fill resin composites (QuiXfil and x-tra fill) or flowable bulk-fill composites (SureFil SDR flow, Dentsply; Venus Bulk Fill, Heraeus–Kulzer; x-tra base, Voco) and incremental-fill composite (Filtek Supreme Ultra Universal Restorative, 3M ESPE) attained the depth of cure claimed by the manufacturers and accepted by the standard. In another study, the DC of Tetric EvoCeram Bulk Fill (high viscosity bulk-fill composite) and x-tra base (flowable bulk-fill composite) were evaluated by FTIR spectrometer and the mentioned DC values of these materials were 41.4% and 43.8%, respectively [28]. In another work, the DC of nine of the available bulk-fill (flowable and high viscosity) composites were measured and it was found a great diversity in the results with the DC ranged from the lowest, 43.6%, for Filtek Bulk Fill (flowable) to the highest, 76.5% for SonicFill (high viscosity) [29].

Surface hardness is one of the most important properties used to compare restorative materials, and is defined as the resistance to permanent indentation or penetration [30]. It is a mechanical property of the restorations that should always be taken into account, especially when they are faced with large areas of masticatory force [5,6]. Substantial surface microhardness of the restoration is one of the main requirements especially in posterior stress-bearing areas [23].

One of the most important factors that affect dental restoration is that it undergoes wear during function or