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Effect of Curing Protocol on the Physical Properties of Bulk-Fill Resin Based Composites Using Novel Monomer

By Dr. Hicham Nuaimi

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Results: The highest hardness value was shown in Bulk Fill 60 sec (HV= 65.15 2.22), while the lowest was observed in Bulk Fill TetricEvo Ceram 40 sec (HV= 61.03 1.63). There is no significant increase in Hardness value during irradiation time for both Bulk Fill Venus Diamond (p=0.456), and Bulk Fill TetricEvo Ceram (p=0.288).

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Conclusion: The mode of polymerization and the light-curing time did not affect on the hardness value of the nanofilled composite resin.

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I. Introduction

Resin-based composite are commonly used in modern dentistry because of their perfect esthetic appearance (tooth colored facade), easy in manipulation and proper mechanical properties. Nanotechnology may be considered as one of the most contemporary advancements in the development of resin-based composites, by increasing filler volume that improved mechanical properties, (1) (2) (3). Additionally, the nano-filler particles provide to show better polishability in compare with conventional resin based composite (4) Durability of resin-based composite entails high mechanical performance, acutely in stress-bearing sites of the posterior tooth that performing high masticatory forces (5).

Researches are not based on improving the inorganic filler components but even more on the development of resin matrix composition by adding novel matrix formulations. Herein, Using of high molecular weight monomers in modern resin based composite suited popular in composite development(6)(7).

Examples of novel resin matrix contain a high molecular weight monomer derived from a core structure based on tricyclodecane–urethane dimethacrylate composition that is said to dispense without diluents and may thus stop high polymerization shrinkage(7),(8).

Incremental layering techniques are suggested not only to reduce shrinkage but also to confirm an adequate polymerization by applying the resin based composite in multiple layers with 2mm thickness (9).

So that researchers invented a new resin-based composite, the bulk-Fill, was presented in clinics use with one increment may reach to 4 mm thickness for curing as one step, therefore no need to waste time due to layering technique. It is mechanical properties of this new material is still an open question while minimum clinical cases are available. Hardness measurements seem to belong to the most sensitive methods for determining this adequate layer thickness(10).

The purpose of this study was to evaluate the hardness value of Bulk Fill nano resin based composite with novel monomer in contrast to conventional materials using different curing time.

II. Materials and Methods

Thirty-two Bulk Fill resin based composite were investigated in this study, one of them containing novel monomer matrix in compare with conventional composite. The materials were selected from various manufacturers based on differences in their matrix and filler composition (Table 1). Specimens were produced in a Teflon mold of (6 mm *4 mm). The mold was filled in one increment then LED light cured directly using (Elipar S10, 3M ESPE, St. Paul, MN, USA) for 40 and 60 seconds. An amount of eight specimens was produced for each type of composite and curing time.

Author: e-mail: dr.hichamnuaimi@gmail.com

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Table 1 : Materials, manufacturer, chemical composition of matrix and filler as well as filler content by weight (w) and volume (v) %

Bulk fill RBCs	Manufacturer	Resin matrix	Filler	Filler (w/v)
TetricEvoCeram	IvoclarVivadent	Bis-GMA, UDMA	Ba–Al–Si-glass, prepolymer filler (monomer, glass filler and ytterbium fluoride), spherical mixed oxide	80/61 (including 17% prepolymers)
Venus® bulk fill	Heraeus Kulzer	UDMA and EBPDMA	Ba–Al–F–Si–glass and SiO_2	65 /38

Hardness value was measured using Vickers hardness test (Nemesis 9000 (INNOVATEST) HaBu, Hauck Pruftechnik GmbH, Hochdorf-assenheim, Germany), three reading was obtained for each sample and the mean of them was represented the mean of hardness value (HV).

Statistical analysis

Results were compared using one- and multiple-way ANOVA and t paired test (α 0 0.05) (SPSS 18.0, Chicago, IL, USA). The results for HV were compared within each different curing time. In the multivariate analysis, the influence of the parameters “material,” “curing time,” were analyzed.

III. Results

According to limitation of this study, Statistically compared the influence of irradiation time and resin matrix on the mechanical properties of Bulk Fill resin based composite. The highest hardness value was shown in Bulk Fill 60 sec (HV= 65.15 2.22), while the lowest was observed in Bulk Fill TetricEvo Ceram 40 sec (HV= 61.03 1.63) as shown in Fig 1. There is no significant increase in Hardness value during irradiation time for both Bulk Fill Venus Diamond (p=0.456), and Bulk Fill TetricEvo Ceram (p=0.288). as shown in table 2.

Table 2 : illustrate the mean of hardness value (SD) of the groups

Bulk Fill 40s	Bulk Fill 60s	TetricEvo Ceram 40s	TetricEvo Ceram 60s
65.15(2.227)	66.63(2.320)	61.03(1.634)	62.55(2.033)

IV. Discussion

Clinically, researchers confidently assumed to use not more than 2 mm as maximum incremental layer thickness to ensure adequate polymerization for predictable successful fillings. So that new type of resin based composite was used of Bulk Fill resin based composite: Venus Bulk Fill and TetricEvo Ceram Bulk Fill reflected to be used as liner material or as bulk fill materials in Posterior restorations (class I and II).For this, specimens were investigated using a Vickers hardness test (HV). Led cure devise have to checked of it is proper intensity for curing frequency.

Manufacturers were used bisphenol-A- dimethacrylate (Bis-GMA) and only formed the organic matrix out of other dimethacrylates(11). Consequently, resin based composite are assumed to be less viscous because UDMA and TEGDMA that forms more flexible than Bis-GMA(12). Additionally, Bis-GMA is said to be more hydrophilic(13), therefore runs a higher risk of water uptake and degradation than other hydrophobic monomers(14) that used in both resin-based composite which reducing the risk of discoloration (15). It has to be mentioned that using different matrix compositions of the two resin based composite, More over when monomer concentration are increased(16)or diluted(17)may do not improving mechanical properties. Scougall-Vilchis et al. demanded that microhardness largely alters on the inorganic filler particles (size, weight, volume) in addition toorganic matrix (18)so, it can be identified that the measured HV values present the average microhardness of both, fillers and matrix. There is limitation in concentration of dimethacrylates-monomer with lower molecular weight because polymerization might be increase(19).

In the micromechanical tests, Venus Bulk Fillshowed to be non significantly superior to TetricEvo Ceram Bulk Fill resin. The Reasons for that performance might be found in both, organic matrix composition and inorganic fillers. Venus Bulk flow differs from fill in the matrix composition of TetricEvo Ceram as it contains additional EBPDMA and a polymerization modulator(20). In addition of the more flexible side groups with solid core of (TCD - urethane) so that its viscosity can be decreased (21)and with the formation of more homogenous copolymer networks.

Lee et al. found out that viscosity of resin based composite increases when filler volume increases (22)So that Decreasing in viscosity is desirable for

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Venus bulk fill (65/38) flow to reach similar levels of flowability, while for TetricEvo Ceram has higher filler content (80/61).In addition increasing filler volume has critical improvement in hardness value, the flexural strength and modulus (23)(24)while in this study it was shown that type of monomer used has affect on the hardness value.

Comparing the results for the hardness value of this study that investigating two different types of Bulk Fill restoration that evaluate resin cure and provide good estimation of the degree of conversion of resin composites,(25), (26).

The depth of cure (DOC) can be affected by some factors relatedto the source of light curing, including the spectral emission (wavelength distribution), light intensity, exposure period, and irradiation distance. Albino et al evaluated the microhardness for nano filled resin-based composite; he showed that there is no significant increase in hardness of resin if they have similar translucency, which is similar to the result of this study. Nicoleta et al showed that irradiation time has less influence on the initial decrease on depth of cure and cure bonding (C–C) double bonds that are direct related to hardness of resin-based composite. Boaro et al. showed that Composite with novel monomer has been shown as one of the materials with the highest results for DOC and low polymerization shrinkage (27).

V. Conclusion

It may be concluded that the mode of polymerization and the light-curing time did not affect the hardness of the nano filled composite resin and that increasing the light-curing time did not improve the hardness of the bottom surface of the composite resin.

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