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MICROHARDNESS AND DEGREE OF CONVERSION OF RECENTLY INTRODUCED BULK FILL COMPOSITE RESIN USING DIFFERENT APPLICATION TECHNIQUES

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ABSTRACT

INTRODUCTION: Recent advances in resin based technology, as regard to new monomers, translucency, initiator system and filler technology, overcome the disadvantages of conventional resin based materials and have led to the introduction of bulk-fill RBCs.
OBJECTIVES: To evaluate the degree of conversion (DC%) and VHN of bulk fill composite using different application techniques in comparison with conventional composite material.
MATERIAL AND METHODS: Bulk fill composite materials Sonicfill (SF), Tetric N Ceram Bulk fill (TB) and Smart Dentin Replacement (SDR) Flow were compared to conventional incremental layering Tetric NCeram composite in terms of microhardness and degree of conversion by Vickers Hardness Test and Fourier transform infrared spectroscopy (FTIR). Total of 40 composite discs were performed in Teflon mold with dimensions 6 mm in diameter 2mm or 4mm thickness and divided into four groups (10 each) according to the material used & its application technique. The Vickers hardness number (VHN) was measured as the mean value from top as well as from bottom of the specimen was obtained and statistically analyzed. For each specimen of each material FTIR spectroscopy with attenuated total reflectance method was performed to assess %DC. Data was collected and statistically analyzed.
RESULTS: Statistically significant differences were shown between materials for all parameters tested using One-way ANOVA. The highest VHN were detected by SonicFill ($p < 0.001$), while the lowest ($p \leq 0.001$) were detected by TetricNCeram. The greatest depth of cure (5.03 mm & 4.47 mm) were exhibited by SonicFill and Tetric NCeram Bulk Fill respectively which was significant different from SDR and TetricNCeram ($p \leq 0.016$).
CONCLUSION: As claimed by the manufactuer, Bulk- fill composite resin materials can be polymerized to an acceptable depth of cure. SF and TB showed the highest values of VHN and DC% in comparison with SDR flow bulk & the conventional Tetric NCeram composite resin material.

KEYWORDS: Packable Bulk, Flow bulk, SonicFill, Vickers Hardness test (VHN), Degree of conversion (DC)

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INTRODUCTION

With the advanced development of clinical techniques and dental materials, composites are the most commonly available dental materials restoring a missing part of the tooth and fulfilling the patient esthetic needs (1). Polymerization shrinkage is one of the major disadvantages of composites, which is estimated in the range of 2 % to 5% (2). When the shrinkage stress is greater than the bond strength itself, the stress generated at the tooth restoration interface, results in debonding (3) which leads to some clinical problems as secondary caries, post operative hypersensitivity & possible inflammation of the pulp. So, incremental technique has been developed in order to reduce the stresses from polymerization shrinkage and obtain adequate mechanical properties of composite (1), where the composite is light cured in increments of thickness not more than 2 mm (4).

However, problems as voids incorporation allow a higher risk of contamination in between the layers and a longer time is needed at the chair side which is considered a practical discomfort (5).

Recent technology in the resin based composite, as regard to filler technology, translucency, new monomers and initiator systems (6) overcome the shortcomings of resin based composite materials and led to the commencement of using bulk fill composite resins (7).

Bulk fills are defined as resin based composites which are light cured in one layer of 4 mm or 5 mm thickness. It has been introduced to simplify the time consumed by the incremental technique. Unlike the conventional composites, bulk fill composites showed a greater light transmission property and a lower polymerization shrinkage stress (PSS) due to the decrease in the light scattering at the filler matrix interface (8). Furthermore, clinicians will not worry about void formation or contamination, which usually happens in between the increments or at the tooth composite surface interface, due to the difficulty in adaptation of the high viscosity packable composite resin (8, 9).

Dentists are greatly expecting from the modern technology, a direct restorative composite resin with good esthetic value, low polymerization shrinkage, precise marginal adaptation and relatively good physico-mechanical properties. When the composite resin allows ease & short time during placement, it is considered greatly desirable characteristics (10).

Recently introduced, SonicFill (SF), is a nano-hybrid low shrinkage, radiopaque, sonically- activated, bulk fill resin based composite material which is designed for all cavity designs in posterior teeth with no additional capping layer. The depth of cure reaches up to 5 mm, as it contains a highly filled proprietary resin and special rheological modifiers that respond directly to the sonic energy. When the sonic energy is delivered by the use of the handpiece, the modifier drops the viscosity up to 87% so, increasing the flow ability of the resin based material and enable ease of packing and accurate adaptation to the cavity walls. As the sonic energy is ceased, the resin based material goes back to a non-slumping, a viscous state for contouring and carving (11).

In this study, a group of composite resin materials were launched in the market as ‘bulk fill composites’ which can be placed in 4mm or 5mm bulk due to their high reactivity to light. However, the development of internal discrepancies occurs with bulk placement and the gap proportion which develops due to the placement of conventional composite in 2mm thickness of each increment needs to be ascertained. The bulk fills resin based composite are claimed to offer clinical advantage as it offers a higher depth of cure and at the same time shows a decline in internal stresses, and consequently leads to precise and accurate adaptation to the tooth substrate.

The null hypothesis to be tested is that the thickness of the increment placed shows insignificant difference statistically on Vickers hardness (VHN) and degree of conversion DC % of bulk fill and conventional resin- based composites.

MATERIAL AND METHODS

Sample size calculation

Summary statement

A sample size of 9 teeth per group (number of groups = 4) (total sample size = 36) is the enough required sample to detect a standardized effect size of 0.571 (minimum difference in the mean Vicker hardness number (VHN) and Degree of conversion (DC%)=2.23 (12), pooled standard deviation=4.498 (13)) of the primary outcome, as statistically significant with 81% power and at a significance level of 0.05. Sample size / group will be increased to 10 teeth per group (total sample size = 40). The sample size was calculated using GPower version 3.1.9.2 software (14).

Material used

The restorative materials used in this study are described in table 1.

Microhardness by Vickers hardness test (VHN)

The depth of cure of high-viscosity TetricNCeram Bulk (IvoclarVivadent, Schaan, Liechtenstein), SonicFill2 (Kerr Corporation, Orange, CA, USA) and low-viscosity SDR (Dentsply Caulk, Milford, DE, USA)flow bulk fill resin composites were used in comparsion with conventional resin composite TetricNCeram

(IvoclarVivadent, Schaan, Liechtenstein) using Vickers hardness test (VHN). A3 shade were selected for all materials tested.

Specimen preparation

Total of 40 discs were prepared for VHN in Teflon molds. It contains a slot with dimensions 6 mm in diameter 2mm or 4mm in thickness (Figure 1). The mold was over packed with composite, and a Mylar strip was used at the top surface of the composite with a glass plate placed in position followed by removal of the excess material from the mold resulting into composite discs (2mm and 4 mm in thickness) (Figure 2).

Each composite disc was light- cured for 20 seconds by LED light curing unit. The glass plate and the Mylar strip were removed and the discs were kept dry at 37◦C for 24 h before measurement using Vickers hardness number (VHN).

GThis Forty discs were divided into four groups of 10 discs each, corresponding to the different bulk-fill restorative composite materials used (n = 10) and further subdivided into 2 group subgroup A (n=5) and subgroup B (n=5) according to the thickness of the material used 2 mm & 4 mm respectively as follows:

Test Group 1: 10 composite discs were filled with sonicfill2 composite using sonic activation.

Test Group 2: 10 composite discs were filled with Tetric N Ceram bulk fill composite material.

Test Group 3: 10 composite discs were filled with Surefill SDR flow bulk composite material.

Control Group 4: 10 composite discs were filled with Tetric N Ceram composite material.

Testing procedure

The Vicker's microhardness test was done (Leco Co. Michigan, USA) using 1000 gm weight. VHN is achieved by dividing the load applied over the surface area made by the indentation using this equation:

VHN = p/ d2 × C.

VHN = Vickers microhardness number.

P = Load applied equal 1000gm.

d2 = Diagonal length square of the indentation.

C = Constant equal 1.854.

Indentions were done at the top surface and the bottom of each disc, the mean values were obtained and statistically analyzed (6).

Degree of conversion (DC)

Specimen preparation

From each composite (shade A3) (n=10), uncured material was inserted into teflon mold of 6 mm in diameter & 2 mm or 4 mm in thickness. A mylar strip was used over the top of the mold to reduce the oxygen inhibition. Each specimen was light-cured for 40 seconds using a LED curing unit. All the discs were polished using silicon carbide abrasive paper under profuse water cooling to create a smooth surface for accurate FTIR measurement. All the discs were kept in distilled water for 24 h before measurements.

Forty discs were divided into four groups of 10 discs each, corresponding to the different bulk-fill restorative composite materials used (n = 10) as mentioned in microhardness test.

DC% measurements:

For each specimen FTIR with attenuated total reflectance method was done to assess DC% using the following equation:

$$DC\% = \left[1 - \frac{C_{aliphatic} / C_{aromatic}}{U_{aliphatic} / U_{aromatic}}\right]\%$$

Statistical Analysis

Normality was checked using descriptive statistics, plots and normality tests, and all variables showed normal distribution, so means and standard deviation (SD) were calculated, and parametric tests were used. Comparison of microhardness and DC% between the four study groups was done using one-way ANOVA. Microhardness ratio was calculated by dividing the bottom and top of each specimen (bottom/top).Significance was set at $p < 0.05$. Data were analyzed using SPSS for windows version 23.0.

Figure 1: Teflon molds with dimensions 6 mm in diameter 2mm or 4mm in thickness

Figure 2: composite discs 2mm and 4 mm in thickness.

Table 1: The materials used in the study, their composition and manufacturer.

Resin composite	Type	Manufacturer	Bonding agent	Maximum increment thickness	Composition according to manufacturer instructions Monomers	Fillers
Tetric N Ceram	Nanohybrid	Ivoclar Vivadent, Schaan, Liechtenstein	Tetric N-Bond	2mm	Urethane dimethacrylate, Bisphenol A dimethacrylate	Barium glass Ytterbium trifluoride Mixed oxide Prepolymer (82-83 wt%)
Tetric N Ceram Bulkfill	Packable nanohybrid	Ivoclar Vivadent, Schaan, Liechtenstein	Tetric N-Bond	4mm	Urethane dimethacrylate Bisphenol A dimethacrylate	Barium glass Ytterbium trifluoride Mixed oxide Prepolymer (79-81 wt%, 60-61 vol%)
SDR	Flowable	Dentsply Caulk, Milford , DE, USA	Prime and Bond NT	4 mm	Modified urethane dimethacrylate Ethoxylated bisphenol A dimethacrylate Triethylene glycol dimethacrylate	Barium glass Strontium glass (68 wt%, 45 vol%)
Sonic Fill 2	Sonic flowable	Kerr Corporation, Orange, CA, USA	Opti bond	5mm	Ethoxylated bisphenol A dimethacrylate Bisphenol A dimethacrylate Triethylene glycol dimethacrylate	Barium glass Silicon dioxide (83.5 wt%)

RESULTS

Microhardness test

Table 2 demonstrates the comparison of VHN at the top & the bottom of the discs between the four study groups demonstrating significant differences between average of both thickness in Group I, II, III and IV.

Sonicfill > Tetric N-Ceram bulk -fill > SDR > Tetric N-Ceram.

Figure 3 shows the average Vickers microhardness ratio of the four study groups (at 2mm, 4mm and average of both thicknesses) where Sonicfill recorded (0.83) at 2mm and (0.87) at 4mm with average (0.85), Tetric N Ceram bulk fill showed(0.85) at 2mm and(0.67) at 4mm with average (0.76), SDR showed (0.76) at 2mm, (0.79) at 4mm with average (0.78) and Tetric N Ceram showed (0.81) at 2mm, (0.48) at 4mm with average (0.64).

Degree of conversion test

Table 3 compares the degree of conversion (DC) between the four study groups at 2mm, 4 mm thickness and the average of both thickness where Sonic fill composite showed the mean (SD) of 67.94 (11.66), Tetric Bulk 63.90(9.62), SDR 50.55(7.91) and Tetric N-ceram.

Figure 4 shows the degree of conversion in the four study groups (at 2mm, 4 mm and average of both thicknesses) where SonicFill had the highest mean of average thickness (63.48) when compared to Tetric bulk fill (58.35), SDR (49.16) and Tetric N ceram (44.4).

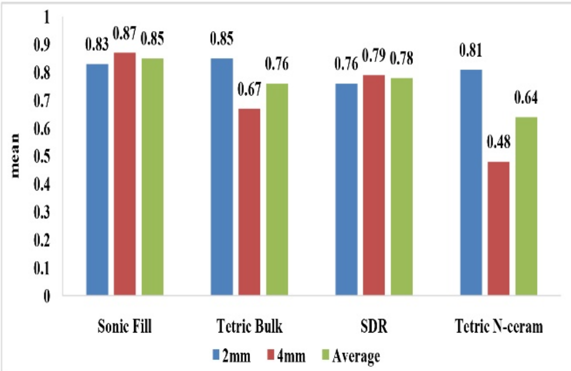

Figure 3: Vickers microhardness ratio of the four study groups (at 2mm, 4 mm and average of both thicknesses)

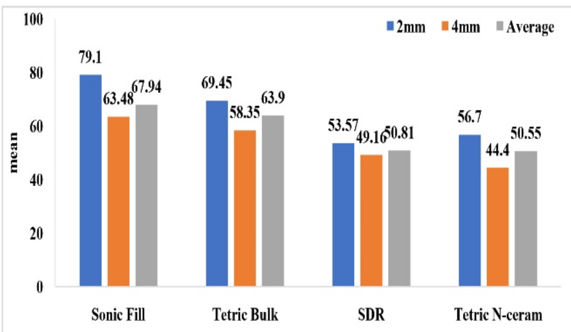

Figure 4: Degree of composite conversion in the four study groups (at 2mm, 4 mm and average of both thicknesses)

Table 2: Comparison of Vickers microhardness at the top and bottom of the specimen between the four study groups

Thickness	Top/bottom	Sonic Fill	Tetric Bulk	SDR	Tetric N-ceram	One-way ANOVA P value
		Mean (SD)				
2mm	Top	112.98 (4.47) a	110.43 (2.51) a	57.73 (8.09) b	54.67 (12.34) b	<0.001*
	Bottom	93.93 (2.80) a	94.13 (10.49) a	41.10 (12.38) b	45.17 (17.56) b	<0.001*
	Microhardness ratio	0.83 (0.02)	0.85 (0.10)	0.76 (0.16)	0.81 (0.13)	0.75
	Paired t-test P value (top vs. bottom)	0.001*	0.13	0.13	0.11	
4mm	Top	97.96 (0.79) a	70.37 (2.16) b	44.94 (8.86) c	41.77 (2.00) c	<0.001*
	Bottom	84.80 (6.15) a	47.07 (2.35) b	35.46 (6.82) b	20.03 (0.70) c	<0.001*
	Microhardness ratio	0.87 (0.06) a	0.67 (0.01) b	0.79 (0.06) a	0.48 (0.006) c	<0.001*
	Paired t-test P value (top vs. bottom)	0.007*	<0.001*	0.004*	0.001*	
Average of both thicknesses	Top	104.63 (8.39) a	90.40 (22.05) a	48.24 (9.18) b	48.22 (10.60) b	<0.001*
	Bottom	88.86 (6.70) a	70.60 (26.66) a	37.58 (8.88) b	32.60 (17.69) b	<0.001*
	Microhardness ratio	0.85 (0.05) a	0.76 (0.12) a,b	0.78 (0.10) a,b	0.64 (0.20) b	0.03*
	Paired t-test P value (top vs. bottom)	<0.001*	0.002*	0.001*	0.004*	

*statistically significant at p value <0.05
a,b different letters denote statistically significant differences between groups using Bonforroni adjustment for multiple comparisons

Table 3: Comparison of degree of conversion (DC) between the four study groups at different thicknesses

Different thickness	Sonic Fill	Tetric Bulk	SDR	Tetric N-ceram	One-way ANOVA P value
	Mean (SD)				
2mm	79.10 (0.28) a	69.45 (3.89) a,b	53.57 (8.15) b	56.70 (6.58) b	0.01*

4mm	63.48 (10.81) a	58.35 (11.81) a	49.16 (6.52) a	44.40 (1.00) b	0.03*
Average of both thicknesses	67.94 (11.66) a	63.90 (9.62) a,b	50.81 (6.96) b	50.55 (7.91) b	0.003*
T-test (4mm vs. 2mm)	0.11	0.43	0.33	0.08	

*statistically significant at p value <0.05
a,b different letters denote statistically significant differences between groups using Bonforroni adjustment for multiple comparisons

DISCUSSION

Many studies have looked at methods to improve DC% and depth of cure of different composite restorative materials. In the current study, different application techniques were performed using four different types of composite resins; SonicFill, Tetric NCeram Bulk, SDR flow bulk and Tetric NCeram composite resin.

SDR is considered a flowable light cured radiopaque bulk -fill composite, which contains fluoride. It is composed of modified urethane dimethacrylate resin, strontium aluminofluorosilicate glass, barium aluminofluoroborosilicate glass, TEGDMA, EBPADMA, camphorquinone, BHT, titanium dioxide, Ultra violet stabilizer and pigments. Its characteristics are the same as any flowable resin but it is photo- cured in 4mm thickness with the least PSS. It shows a self leveling property allowing accurate adaptation. It is available in 1 universal shade and it should be capped with conventional composite resin material (15).

Sonic fill system composed of a specialized hand piece that provides sonic energy and a bulk fill composite compules. Polymerization shrinkage stress (PSS) compensation technique in SF system is due to the use of a resin that has high filler content (84%) and low shrinkage properties. It also contains glass oxides, silicon dioxide (5–10%), 3-trimethoxysilylpropyl methacrylate (10–30%), ether (1–5%), and TEGDMA (1–5%) (15).

Tetric NCeram Bulk is considered a nano- hybrid resin material. The matrix is composed of DMA (21% wt) and the inorganic fillers are barium, mixed oxides, YF and polymer (81% by wt). Other components are catalysts, pigments (<1.0% wt) and stabilizers. Total percentage of fillers is 77% by weight or 54% by volume with a mean particle size of 550nm. It has an inhibitor of light sensitivity providing a long time for contouring of restoration and a shrinkage stress inhibitor to obtain a precise marginal integrity and a photoinitiator (Ivocerin) to allow curing of 4mm increment thickness (15).

A novel technology in composite resin is the use of more than one initiator system in the same material (16). Besides, camphor-quinone (CQ) which is the most commonly used photo-initiator and tertiary -amine, other photoinitiators as TPO (17) and Ivocerin (18) are also included. The emission spectrum of the most commonly used LED curing units is adjusted in the range of 430–480 nm which is peak of absorption of the Campherquinone photoinitiator, the absorption wavelength range of TPO is 350–425 nm(15) and Ivocerin is from 370–460 nm . So, LED chips have been inserted to overcome this absorption mismatch, in what is called poly wave LED (18).

Microhardness

Hardness is related to rigidity, mechanical strength and resistance to intra oral softening, which has a role in the clinical success and longevity of restorative materials. In this study, VHN has been used to evaluate microhardness, which represents an indicator for degree of polymerization of light curing composite resin based materials which is considered relatively simple & accurate technique (19).

The results of this study (Table 2 and figure 3) showed significant differences in the means of microhardness values among the four study groups I,II,III and IV (means=0.85,0.76,0.78 And 0.64)respectively with Group I showing the highest microhardness mean values. When sonic energy is delivered from the handpiece, the viscosity drops up to 87% by the incorporation of modifier resulting in higher flowability of the composite, enable quick & ease of placement and accurate marginal integrity. As the sonic energy is ceased, the composite resin material goes back to a non-slumping, viscous state suitable for contouring. It contains a highly filled proprietary resin and a special rheological modifier that reacts to sonic energy increasing the depth of cure to 5mm (10).

The results of this study are the same with the study done by Alrahlah et al., (2014) (6) who compared the different microhardness numbers (Vickers hardness number) using different bulk fill dental composites, including sonicfill composite (sonic activated composite resin) where the results showed maximum Vickers hardness numbers (VHN) for sonicfill composite resin.

Effect of the type of material used on the microhardness values

SF composite exhibited the greatest VHN values from all the tested materials as shown tables 2 and figure 3, followed by Tetric NCeram bulk fill and the lowest VHN values for SDR Flow bulk fill . This is in accordance with another study (20) which stated that SF system scored the greatest values from all the tested composite So, it can be used instead of conventional composite resin material. This may be due to:

(1) The Nano filling technology which led to development of composite resins with better mechanical properties than the other types of resin-based composites (20).

(2) The optical properties of resin based composite materials and the optical transmission coefficient differs according to the material composition including the particle size and type (21).

As shown in table (1) SF have the highest filler- loading ratio (83.5%) followed by TB (79-81%) and SDR flow bulk (68%) these results are in accordance with other study (21), as an increase in filler content ratio leads to greater hardness values.

Concerning the fillers size, the filler particles incorporated in the composite resin scatter light. This scattering effect is greater when the wavelength of the activating light approaches the particle size of the inorganic fillers. So, reducing the light transmitted through the resin-based composite (22).

The smaller the inorganic filler particles size (0.19-3.3 μm), the greater is the value of light transmittance, where as composite resin material with larger filler particle size (0.04-10 um) demonstrated the least light transmittance (22). The SF composite resin material contains the smaller size of the inorganic filler particles which is in accordance with other study (21). As regard to the type of the particle, the zirconium is harder than the other heavy metal glass and also, the crystalline form (zirconium silica) diffuses more light& harder than non-crystalline form (glass) (21).

The optical characteristics of SF are the reason of its higher VHN when compared to nanohybrid composites TB and conventional TC which are in accordance with another study (10). Also TB composite resin material showed higher statistical VHN value than SDR Flow bulk due to the incorporation of Ivocerin as a polymerization booster which is a highly reactive photo-initiator. It allows a deeper depth of cure than any other types of composites & the application of increments up to 4 or 5 mm in a very short time. Also, the presence of inhibitor to light sensitivity in the composition performs as a protective barrier to the ambient light in the operating room (20).

The thickness of the material and its effect on microhardness

The thickness of resin based composite affects the microhardness values (23). In this study, the microhardness value decreases as the thickness of resin is increased which is in agreement with other study demonstrating that at the bottom the microhardness value was statistically significant from the top as the samples were 4 to 5 mm thickness (24).

It may be due to that at the top surface, enough light energy reaches the photoinitiator and polymerization reaction starts when light passes across the core of the composite. The intensity of light is decreased due to the absorption and dispersion by inorganic fillers and resin matrix. This decrease leads to improper curing and decline in VHN values from the top surface to bottom surface. This finding is in accordance with another study (25) demostrating the difference in microhardness values between the top surface & the bottom surface for all composite resin materials tested.

Above 80% ratio between the bottom& the top surfaces is considered as the minimum acceptable threshold. So, in the present study the composite whose bottom / top ratio is 80% or above can be polymerized in the 4 mm or 5mm bulk as shown in figure (3).

Degree of conversion

DC% is considered significantly linked to biocompatibility, color stability and the values of mechanical properties resulting in higher microhardness values , clinical success and longevity of the restoration (26).

Increasing the filler ratio decreases the volume of the resin for polymerization & cross linking therefore, increasing the microhardness values (27).

In this study, SF and TB showed the highest depth of cure from all the composite tested, showing statistically insignificant difference $p > 0.05$. SF contains the largest inorganic filler ratio in comparison with the other composite materials tested. SF handpiece delivers sonic energy through a special handpiece increasing the flow ability and therefore results in ease of packing and contouring of the composite (28). The good Degree of conversion DC% is usually as a result of the refractive index matching of the organic resin matrix & the inorganic fillers, enhancing transmission of light. So, reducing the differencesin the refractive index of the organic matrix & the inorganic fillers, greatly improves DC% and higher depth of cure (29).

Camphor-quinone is the most commonly known photoinitiator in the composite resin materials absorbing light in the range of 450 - 490 nm wavelength. Other composite materials contains different photo-initiators other than CQ for example; Tetric Bulk fill composite resin contains Ivocerin (a dibenzoyl germanium compound) the new photo initiator system which absorbs light in a wider range of wavelengths (370 - 460 nm). Therefore, enhancing reactivity and higher depth of cure is obtained within the suitable formulations (30).

The Optical characteristics are considered very important for the polymerization and the esthetics of resin based materials. Nano-hybrid composites have higher translucency as the inorganic filler size are smaller than the light-wavelength causing less scattering of light photons (31). Therefore, a proper photo-polymerization across the whole thickness of the bulk fill resin based material is crucial for the success & stability of the restorations.

Bulk fill composites have a higher translucency than the other conventional composites (7). It is believed that light-transmission is related to the opacity of the material (32), the degree of conversion %DC observed at 4 mm or 5mm thickness for all the tested bulk fill may be due to their decrease in opacity. Greater translucency is obtained by the reduction in the ratio of inorganic filler (33). In experimental resin based composites it was observed that greater inorganic filler / organic matrix ratio result in decrease in degree of conversion (34). The selection of the matrix composition showed a strong impact on the DC% of composite materials (35). As described by the manufacturers', most of the commercially available composite resin based materials contain UDMA, in addition to the Bis-GMA (bisphenol A glycolmethacry-late). UDMA was proven to exhibit higher %DC than Bis-GMA, containing higher molecular wt% (UDMA 470.0, Bis-GMA 510.6) and higher concentration of carbon double bonds (UDMA 4.25 mol/ kg, Bis-GMA 3.90 mol/ kg) & lower viscosity (UDMA 23.1 Pa s, Bis-GMA1200 Pa s) (36). The Copolymerization of Bis-GMA, UDMA and ortriethyleneglycol dimethacrylate (TEGDMA) is used to increase DC% and create dense, strongly cross -linked and strong polymer networks (37). Elastic modulus has shown an important role in estimating the DC %. It is enhanced by the high filler ratio and the concentration of BisGMA (36). Both factors lead to decline in %DC and therefore lower Polymerization shrinkage stress. With 60% filler volume fraction, Sonicfill and Tetric NCeram Bulk Fill are considered among the high filler content & less translucent bulk fill of all the materials tested in this study. For TB composite resin, DC% at greater depth is obtained by the incorporation of photo-initiator system containing the conventional CQ and Ivocerin® (Bis-4-(methoxybenzoyl) diethylgermanium Ge-3).It is a dibenzoylgermanium derivate similar to (DBDEGe) dibenzoyldiethylgermane (18).

As small amount of light energy is delivered at larger material thickness, the more the sensitivity of the initiator system, the faster is the polymerization reaction (18).All bulk fill composite resin materials demonstrated lower DC% at the top surface when being compared to 2mm & 4 mm thickness as light-cured for 30 seconds. It is in agreement with a study that reported similar finding (38) which is related to other factors, such as the increase in the difference of temperature and the thickness of the material during photo-polymerization, difference in the depth and the degree of cross linking and its oxygen inhibition property. In this study, it is uncommon as the mylar strip was pressed at the top of the Teflon mold to decrease the oxygen-inhibition also, the proper finishing and polishing of the composite discs was performed.

The composition of the material (resin matrix & filler content) and its translucency influences the degree of conversion (31). Our main concern is whether a bulk fill technique cures properly in the deeper portions and up till now, there are few studies evaluating the kinetics of photo-polymerization and the degree of conversion of different commercially available bulk fill materials (39). One of these studies showed that SDR, TetricBulk and Venus Bulk resulted in proper curing & greater depth of cure at the deepest portion of a 4mm thickness (40). Generally, as claimed by the manufacturers the depth of cure and the degree of conversion of different bulk fill composite resin material can be considered reliable (6).

Therefore, the null hypothesis, that increment thickness and depth of cure showed no significant impact on VHN or DC % of different bulk fills and conventional composite resin materials has to be rejected.

CONCLUSION

1-Acceptable depth of cure can be reached using Bulk fill composites as claimed by the manufactuer.

2-SF and Tetric bulk showed the highest values of depth of cure and microhardness values (VHN) when compared to SDR bulk flow and conventional Tetric NCeram composite resin material.

CONFLICT OF INTEREST

The authors declared no conflict of interest regarding this study.

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