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Bulk Fill Kompozit Rezinin Farklı Tekniklerle Uygulanmasının Mikrosızıntı Ve Mikrosertlik Üzerine Etkisinin Değerlendirilmesi

The Effect of Different Application Procedures on Microleakage and Microhardness of a Bulk-Fill Composite Material

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ÖZ

Amaç: Bu çalışmanın amacı tek tabaka ve tabakalama tekniğiyle uygulanan bulk-fill kompozit rezinin (Tetric Evo Ceram Bulk-Fill; IVW ve IVB, Ivoclar/Vivadent, Liechtenstein) mikrosızıntı ve mikrosertlik özelliklerinin karşılaştırılmasıdır.

Yöntem: Çekilmiş 28 adet çürüksüz üçüncü molar diş üzerinde hazırlanan Sınıf I kaviteler (4X4X4mm) sırasıyla 2 ve 4 mm'lik tabakalar halinde iki farklı renkte rezin kompozitle restore edildi. Mikrosızıntı testi için dişler bazik fuksin kullanılarak boya penetrasyonuna tabi tutuldu. Restore edilen dişler daha sonra bukko-lingual yönde ortadan ikiye separe edildi. Mikrosızıntı, stereomikroskop kullanılarak x20 büyütmede değerlendirildi. Separe edilen diş parçaları akrilik rezin bloklara yerleştirildi ve uygulanan kompozitin 1-2-3 mm derinliklerinde mikrosertlik testi gerçekleştirildi ve elde edilen verilere istatistiksel analiz uygulandı (Wilcoxon Signed Ranks Test, ANOVA, Bonferroni).

Bulgular: Mikrosızıntı testinde tek tabaka ve tabakalama tekniği arasında istatistiksel anlamlı fark görülmedi ($p>0.05$). Mikrosertlik testinde iki farklı renk (IVW, IVB) kompozit rezin restorasyon arasında benzer şekilde istatistiksel anlamlı fark belirlenmedi ($p>0.05$). Tek tabaka halinde uygulanan kompozit rezin restorasyonlarda 1,2 ve 3 mm derinliklerinde üst tabakadan alt tabakalara doğru azalan mikrosertlik değerleri arasında istatistiksel olarak anlamlı fark belirlendi ($p< 0.05$).

Sonuç: Mikrosızıntı bulguları, farklı uygulama tekniklerinin kompozit rezin materyalin büzülmesi üzerine etkisinin olmadığını ortaya çıkardı. Mikrosertlik bulgularına göre, tek tabaka uygulanan kompozitlerin istatistiksel olarak anlamlı sertlik farklılıklarının olduğu görülmüştür.

Anahtar Kelimeler: Bulk fill kompozit, İnkremental teknik, mikrosızıntı, mikrosertlik

ABSTRACT

Introduction: *The aim of the study was to compare microleakage and microhardness properties of bulk-fill composite resin (Tetric Evo Ceram Bulk-Fill IVW and IVB, Ivoclar/Vivadent, Liechtenstein) following bulk and incremental insertion techniques.*

Methods: *Class I cavities (4X4X4mm) were prepared in 28 intact caries-free third molars and restored incrementally with horizontal layers of 2mm and bulk technique of 4mm thickness, respectively. To test the microleakage, the teeth were subjected to basic fuchsine dye penetration. They were subsequently sectioned buccolingually. Microleakage was evaluated under stereomicroscope and microhardness was measured by Vickers microhardness test (Shimadzu HMV-2, Japan) on sectioned surfaces of 1-2-3mm depths and analyzed statistically.*

Results: *There was no significant difference among microleakage scores between bulk and incremental insertion techniques (ANOVA $p>0.05$). In microhardness tests, there was no significant difference between the two shades (IVW, IVB) (ANOVA $p>0.05$). There was a statistically significant difference in microhardness through the material among 1, 2 and 3 mm depths when bulk insertion technique was used ($p< 0.05$).*

Conclusion: *Microleakage findings revealed that there was no difference among insertion techniques on shrinkage of the material. There was a statistically significant difference on microhardness through the bulk filled insertion of the tested composite resin.*

Keywords: *Bulk fill composite, increment technique, microleakeage, microhardness*

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INTRODUCTION

Soon after the introduction of resin composites, one of the most important features was the degree of cure that was shown to affect the clinical success.[1,2] The factors such as resin type, filler amount, resin shade, intensity and spectrum of the activation light influence the cure depth of the resin composite. Therefore, increments of limited thickness have been suggested to be the gold standard in applying light curing resin composites.[3,4] Maximal increment thickness has been generally accepted as 2 mm.[5] The primary aim to apply resin composite in layers was to reduce shrinkage stresses. However, this is time consuming in deep cavities and has the risk of incorporating air bubbles and the possibility of contaminations between the increments. Recently, the new composite materials so called 'bulk fill' were introduced to the market that are claimed to be curable up to 4 mm thickness.

Resin composites have undergone continuous development as regard to their filler type, size and initiator variety and bulk fill materials were introduced by changes in the composition of the resin composite.[1] Besides easy handling properties, the restorative material should be biocompatible and needs to have good mechanical characteristics and low shrinkage. Although low residual stress and good adaptation are important, thorough polymerization is an equally important consideration for any material and filling technique.

The main concern regarding a bulk technique is whether the composite cures fully enough in the deeper portions to create a material that has acceptable physical and biocompatible properties.[6] A number of different techniques such as scraping away the unset material and measuring the remaining specimen, measuring top and bottom hardness have been employed to measure the properties of the polymerized resin composite further away from the light source.[7] Using microhardness at various restoration depths as an indicator and hardness measurement has been shown to be a practical method to indirectly determine degree of conversion for a given resin composite.[8] Microhardness profiles can be used to interpret depth of cure.

On the other hand, polymerization shrinkage affects the bond integrity of the resin composites, leading to problems such as microleakage, postoperative sensitivity, and furthermore to secondary caries.[9] Studies on proper bonding materials and ideal resin compositions are of great interest.[10,11] Microleakage can be studied in-vitro using dyes, chemical tracers, radioactive isotopes, scanning electron microscopy, neutron activation analysis, micro-ct and electrical conductivity.[12,13]

Consequently, the first aim of this study was to evaluate polymerization shrinkage by dye penetration and the second aim is to evaluate the effect of cure depth by microhardness test in the bulk fill resin material using two different insertion techniques. The null hypothesis was that the shade and insertion technique of the bulk fill resin composite would not interfere with the marginal microleakage and depth of polymerization.

Figure 1-Standard box-shape Class-I cavities (4×4 mm wide, 4 mm deep)

MATERIALS AND METHODS

Specimen preparation

Twenty-eight non-carious human third molars kept in distilled water at 4°C for a maximum of 4 weeks following extraction were used. The occlusal tubercles were flattened. Standard box-shape Class-I cavities (4×4 mm wide, 4 mm deep) were prepared at the center of the flattened occlusal surface, with the pulpal floor ending

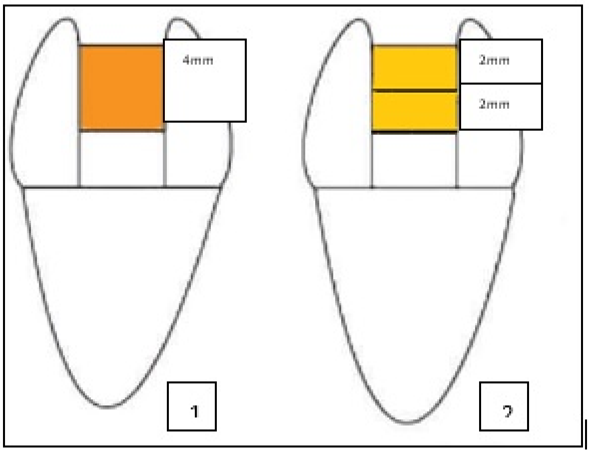

Figure 2- The teeth were randomly divided into 2 experimental groups as follows: 1) bulk (fill) insertion technique, 2) incremental insertion technique

at mid-coronal dentin, using a cylindrical medium-grit (100 µm) diamond bur (842, Komet, Lemgo, Germany) in a water-cooled high-speed aerator (Figure 1). All cavity surfaces were carefully verified for absence of enamel and/or potential pulp exposure. The teeth were randomly divided into 2 experimental groups (n=14) as follows: 1) bulk (fill) insertion technique, 2) incremental insertion technique (Figure 2). Each group was further divided according to shade of the composite into two (Tetric Evo Ceram Bulk Fill IVW and IVB composite (Ivoclar Vivadent, Schaan, Liechtenstein).

In Group I, cavities were filled with bulk technique, after which the 4 mm Tetric Evo Ceram Bulk Fill IVW or IVB composite (Ivoclar Vivadent, Schaan, Liechtenstein) was light-cured for 20 s using a high-power LED light-curing device (Axdent Led Rainbow Curing Light, China). The light efficiency of the curing unit was checked for accuracy before starting each restoration.

In Group II, the cavities were filled with the incremental technique using horizontal layers, after which every 2 mm Tetric Evo Ceram Bulk Fill IVW,or IVB composite (Ivoclar Vivadent, Shaan, Liechtenstein) layer was light-cured for 20 s using a high-power LED light-curing device (Axdent Led Rainbow Curing Light, China).

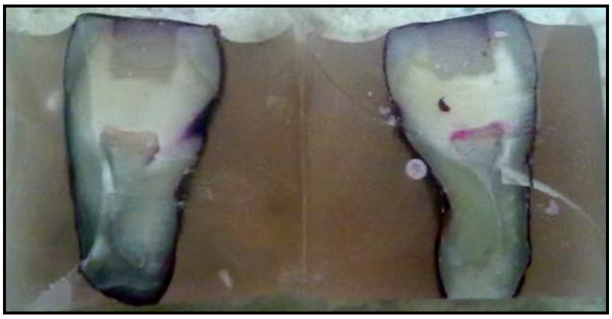

Figure 3- Cross sectional views of the specimens

Microleakage test:

All the teeth (n=28) were stored in distilled water at 37°C for 30 days. The samples were then blotted dry and the roots were sealed with composite. Two layers of an acid-resistant varnish (nail polish) were applied to all surfaces of the teeth except the area 1 mm adjacent to the restoration margins. All specimens were then immersed in 0.5% basic fuchsine dye solution at 37ºC for 24 hours. The teeth were rinsed under running water, blotted dry, embedded in polyester blocks and then sectioned bucco-lingually with a water-cooled diamond wheel saw (Isomet, Buehler, Lake Bluff, IL, USA) (Figure 3). The cut surfaces were polished serially by using 800- and 1000-grit silicon carbide paper (Buehler), followed by 1.0-µm and 0.05-µm alumina suspensions (Buehler).

Dye penetration at the margins (n=56) were examined by two independent evaluators using a stereomicroscope (Leica CLS Stereozoom, Switzerland) at 20x and scored according to the following criteria: 0=no dye penetration; 1=partial dye penetration along the axial wall; 2=dye penetration along the axial wall, but not including the pulpal wall; 3=dye penetration to and along the pulpal wall.

Microhardness test:

After microleakage test, microhardness was measured on three points on the sectioned surfaces of each sample, using a Vickers hardness profiles (Shimadzu HMV-2, Japan). The defined distances (ı) were: 1mm, 2mm, 3mm from the surface of the restoration. VHN measurements were made at a load of 100 g for 15 s at the same axis at three points with 1mm intervals. For each of the 2 groups (bulk and incremental techniques) two shades IVW or IVB of the bulk-fill composite were used. 56 specimens were prepared and thus 56 VHN measurements were made at each of the defined distances.

RESULTS

Microleakage test:

The difference between dye penetration scores of the bulk fill technique and incremental technique were analyzed by the Wilcoxon Signed Rank test Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL, USA). Dye penetration scores of the composite insertion techniques are presented in Table 1.

The results demonstrated no significant differences between bulk fill and incremental technique (G_1; p= 0.381, G_2; p= 0.126). No significant differences were found between the two observers according to the Kappa test. (Incremental technique Weighted Kappa= 0.796, bulk fill technique Weighted Kappa= 0.651)

Microhardness test:

There were no significant differences between the two shades (IVW, IVB) for each insertion techniques (ANOVA p>0.05). For the incremental technique, there were no significant differences between all depths (1: bottom layer, 2: middle layer, 3: top layer) (Bonferroni test, $p_{1,2}$, $p_{1,3}$, $p_{2,3}$, p>0.05). For the bulk technique, the microhardness values were showing a statistically significant decrease from the top to bottom. There was a significant decrease between bottom-middle layer ($p_{1,2}$ = 0.024), middle-top layer ($p_{2,3}$ = 0.011) and bottom-top layer $p_{1,3}$ < 0.001. The difference of the shade did not affect the microhardness of the composite in any of the layers for both insertion techniques ($p > 0.05$). The mean microhardness values obtained with the different methods are shown in Table 2.

DISCUSSION

Bulk fill composites are promising restorative materials for pediatric dentistry because of their need for shorter chair-time. Bulk-fill composites claims that the total cure of the material is possible with 4 mm thicknesses and the material do not show shrinkage. Major disadvantages of resin composites have always been related to polymerization shrinkage that is in relation with the thickness of cured material causing microleakage. This process causes internal stresses within the structure of the material as well as cusp deformations, which in turn might create micro cracks within the tooth and cause postoperative sensitivity.[14]

Composite Insertion Technique	Observers	0	1	2	3	Total
Incremental	Observer 1	18	14	17	7	56
	Observer 2	22	13	16	5	56
Bulk	Observer 1	29	6	12	9	56
	Observer 2	30	11	13	2	56

Table 1- Dye penetration scores of the composite insertion techniques

Lee *et al*. has shown previously that incremental technique decreases cusp deflection when compared to bulk fill technique.[15] Similarly, Park *et al*. have shown that horizontal and oblique increments decrease cusp deflection when compared to bulk fill technique.[16] However, Idriss and colleagues found no significant difference between bulk and incremental filling techniques when they examined marginal gap size in Class II composite restorations in vitro.[17] Sarret *et al.* and Campodonico *et al.* have reported that decreasing the number of increments and even using bulk fill technique might result in successful applications.[18,6] Winkler *et al*. have reported that incremental technique has no advantage over bulk filling when approximal stresses are considered.[19] Within the limitations of this in vitro study, we concluded that the incremental and bulk filling techniques we used resulted in no significant difference in the amount of microleakage for the bulk fill composite that we evaluated.

Composite Insertion Techniques	Shade	Bottom surface	Moderate surface	Top layer
Incremental	IVW	61.75 ± 4.28	63.17 ± 4.48	63.8 ± 5.1
Bulk	IVB	63.71 ± 4.65	63.48 ± 2.8	65.35 ± 2.88
	IVW	62 ± 6.38	64.37 ± 4.86	66.6 ± 4.4
	IVB	62.32 ±5.02	65.48 ±3.89	66.25 ± 2.99

Table 2- The mean microhardness values obtained with the different insertion techniques

The success of composite resin material in relation to microleakage highly depends on the success of the bonding agents. It was interesting to note that there was no difference among insertion techniques on microleakage where all the restorations in this study were prepared without using a bonding agent. We evaluated the free shrinkage behavior of the bulk fill resin composite by using microleakage findings of unbounded in-vitro restorations. It is not a clinically recommended procedure but this provided the effect of the shrinkage more easily seen without the positive effect of the bonding agent, similarly.[20]

The study made by Poskus *et al*. revealed the fact that the occlusal layer is harder than the cervical layer in bulk fill technique in Class II cavities.[21] Similarly, microhardness showed a progressive decrease with increasing depth for bulk fill technique. In this study, although it was found that restoration at depths of 2 and 3 mm had hardness values lower than of the value at top surface with incremental technique, the difference was insignificant. Note that we could not calculate a bottom-to-top ratio because our hardness measurements started at 0.5 mm below the top surface. Readers also should be aware that we sectioned, embedded and polished the composite restorations to achieve a surface suitable for microhardness measurements. Any of these procedures could have increased the hardness values. Thus, hardness values of restorations produced in vivo with the same composite chosen for this study may even be lower than the values reported here.

Additionally, Tanoue *et al.* have indicated that the color pigments of the composite material have an influence on the light transition.[22] This, in turn might result in under-polymerization of dark colored composites. Lazarchik *et al.* have reported that dark colored bulk fill composite might reveal lower micro hardness at 2.5 and 3 mm depths compared to light colored bulk fill composites. This difference was slightly less in nanohybrid composites except 3mm of depth.[14] These studies stated that although the color difference influences the degree of polymerization, decreasing the particle size in the inorganic content reduces this effect. The results of the present study revealed that there was no difference between different colored bulk fill composites using both bulk fill and incremental technique is in accordance with these results. (Incremental technique, p = 0,376, bulk fill technique, p = 0,826)

CONCLUSION

As a conclusion, the effect of different filling techniques using bulk fill composite on microlekage was not significant in this study. The appealing advantages of bulk fill composites are shorter chair time and easier application but polymerization problem within the material that was shown with microhardness test posses the hazards of monomer release that needs further evaluation.

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