The effect of filling techniques on compressive strength of dental composites
Efeito de técnicas restauradoras na resistência à compressão de compósitos restauradores odontológicos

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ABSTRACT

The aim of this study was to evaluated the effect of filling techniques on compressive strength of six dental composites. The composites (Z100, Surefil, P60, Definite, Prodigy Condensable, and Solitaire) were placed in circular aluminum molds with 2.5 mm in inner diameter and 5 mm in height. Each composite was divided into two groups (n=8): Group 1 – the composite was placed in the mold in bulk increment of 5 mm thick, covered with Mylar strip and photoactivated for 40 seconds; and, Group 2 – the composite was placed in two increments of 2.5 mm thick each and photoactivated for 40 seconds for each increment. Afterwards, the specimens were stored in a dark container, with distilled water at 37º C for 24 hours before test. After storage, the specimens were submitted to compressive strength in a Instron device at a crosshead speed of 1.0 mm/minute. Data were submitted to ANOVA and Test t – Student (5%) and showed that for each increment of condensable composite should not be greater than 2 – 3 mm and must be properly polymerized to get optimal mechanical properties. Z100 and P60 composites showed higher compressive strength values, while the lowest values were found for Prodigy and Solitaire.

UNITERMS
Composite packable; operative dentidtry, compressive strength, analysis of variance

Introduction

Restorative resin composites were brought up into dentistry in the mid-1960s, and these materials have developed significantly, allowing their application on both anterior and posterior areas[15,21]. However, problems such as marginal leakage, recurrent caries[10], polymerization shrinkage, and inappropriate proximal contact can occur after their use[16].

Recently, a new concept was developed in order to provide the bases to manufacture a packable or condensable posterior composite resin. For the manufacturer, the restoration must be built up in increment with 5-6 mm.

Nevertheless, these posterior composites were still not as easy to handle as dental amalgam, associated with the problem of technique sensitivity and an incremental placement[12]. The depth of cure is limited and it depends on several variables such as material, exposure time, color, location of light source and quality of the light source[1,4,5,7,13,15,17,18].

Thus, the purpose of this study was to evaluate the effect of the restorative techniques on compressive strength of the six restorative composites.

Materials and methods

Five restorative available packable composites Definite (Degussa Huls), P60 (3M), Prodigy Condensable (Kerr), Solitaire (Heraeus Kulzer), SureFil (Dentsply/Caulk) and a conventional composite Z100 (3M) were used in this study. The composition of these materials is shown on Table 1.

Table 1 – Composition of the restorative resin composites

Composite	Composition			
	Organic/inorganic Matrix	Inorganic Filler	Filler size	% in Volume (Filler)
Z100	Bis-GMA and TEGDMA	Zirconia/Silica	0.01-3.5 μm	66**
Surefil	Modified BIS-GMA urethane resin fluoride, silanized barium and silica	Boro-Silicate-Aluminum	0.04-0.1 μm	66*
P60	Bis-GMA, UEDMA and Bis-EMA	Zirconia/Silica	0.01-3.5 μm	61**
Definite	Organically modified ceramic-matrix (ORMOCER)	Barium glass and silica	1.0 μm	88**
Prodigy Condensable	Bis-GMA, TEGDMA and RCA	Coloidal Silica and Boro-silicate-barium glass	0.6 μm	62*
Solitaire	Bis-GMA, PENTA, HTMA, ETMA	Boro-Silicate, Aluminum, Barium and SiO2	2.0-20 μm	90%**

* Source: Dental Advisor, 6(10), Nov 1999.
** Manufacturer's information

The restorative composites were placed in a circular aluminum mold of 2.5mm in inner diameter and 5 mm in height. Each composite was separated into two groups. In the first group the composite was placed in the mould in bulk increment of 5 mm thick, covered with a Mylar strip and pressed with a glass lab, photo-activated for 40 seconds with intensity of 450 mW/cm^2, using an Ultralux Electronic (Dabi-Atlante). The light intensity was measured with a radiometer (Curing Radiometer, model 100, Demetron/Kerr, Danbury, CT 06810, USA). In the second group, the composite was placed in two increments of 2.5mm thick each, and the photo-activation was similar to the first group for each increment. Afterwards, the specimens were stored in a dark container, with distilled water at 37^o C for 24 hours before test. Eight specimens were prepared for each material and group, totaling 96 specimens.

After storage, the specimens were submitted to compressive strength in an Instron machine (4411 – Canton, Mass, USA) at a crosshead speed of 1.0 mm/minute until failure. All statistical analyses were conducted at a significance level of 5%. Data were checked for test distribution revealing normal test distribution for all groups. Two-way analysis of variance (ANOVA) and Test *t* – Student were carried out on fracture data for each material and restorative technique.

Results

Table 2 shows the mean compressive strength (MPa) of six composite for two restorative techniques (Bulk and two increments). For bulk increments, the compressive strength of Z100 and P60 was significantly higher than the one of Definite, Prodigy and Solitaire (p<.05). Surefil and Definite were significantly higher than Prodigy and Solitaire (p<.05). Solitaire showed the lowest compressive strength values.

When two increments were used, Z100 and P60 showed compressive strength values significantly higher than Definite, Prodigy and Solitaire (p<.05). Surefil was significantly higher than Prodigy and Solitaire (p<.05). Prodigy showed the lowest compressive strength values.

When the techniques were compared for each composite (Table 2), the compressive strength for two increments was significantly higher than bulk increment for Prodigy and Solitaire (p<.05). No difference was found for Z100, P60, Surefil, and Definite (p>.05).\

Discussion

Restorative resin composites have been extensively utilized in dentistry for morphofunctional recovery of anterior and posterior teeth. However, these material decrease the compressive strength when increments over 2 to 3mm and decreased light intensity were used.

Results presented on Table 2 show that for Z100 and P60 bulk and two increments promoted higher compressive strength than Definite, Prodigy, and Solitaire. However, Prodigy and Solitaire showed the lowest compressive strength, and Surefil and Definite demonstrated intermediate values.

Table 2 – Mean of compressive strength (MPa) for five packable composite and one conventional composite in relation to bulk and two increments restorative techniques.

Composite	Bulk increment	Two increments
Z100 (D)	341.81 (66.73) a	339.98 (94.14) a
P60 (F)	299.49 (62.59) a	335.42 (70.86) a
SureFil (S)	251.01 (77.65) ab	317.20 (60.69) ab,c
Definite (D)	213.25 (56.88) b	233.07 (63.02) bd
Prodigy (P)	120.25 (62.18) c	* 205.71 (38.83) de
Solitaire (SO)	75.43 (31.76) cd	* 223.34 (38.83) cd

Means followed by different small letter in the column indicate statistical difference at the 95% confidence level (Test *t* – Student, p<.05). ( ) Standard deviation.
* significantly different groups (Test *t* – Student, p<.05).

Restorative composites present significant differences in the resin composition matrix as well as in the filler, which influence the properties of the material, including compressive strength[2,16,19]. Besides, another factor is the light intensity which determines the degree of polymerization of resin composite[20,22]. Miyazaki et al.[14] (1998) related that the compressive strength of the composite decreases with decreased light intensity. Data of this study showing that the shortest irradiation time does not always achieve the optimal mechanical properties is a very important finding and is in agreement with the results of Baharav et al.[3] (1997).

In this study, Prodigy and Solitaire showed statistical difference between both and bulk increments methods. Each increment should not be greater than 2-3 mm thick, and must be properly cured. Davidson-Kabal et al.[6] (1997) showed that different composites react differently according to light intensity and exposition time.

It is evident that polymerization is directly related to filler particle size, % in volume, inorganic filler, and organic matrix in dental composite[9,11]. Z100 and P60 composites demonstrated higher compressive strength values, probably because the composite presented the same inorganic filler. According to Asmussen & Peutzfeldt[2] (1998) and Dulik et al.[8] (1981) the compressive strength depends on diluent monomer, which is higher when the diluent concentration is decreased. Another factor that influences is that the filler particle size light-scattering within the composite is increased as the particle size of the fillers approaches the wavelength of the activating light. The light scattering will reduce the amount of light transmitted through the composite[5]. Therefore, the larger particle composite showed the greatest depth of cure, since it was the least affected by light-scattering[7]. However, in this study results are different because Solitaire has large particle size and showed lowest values of the compressive strength in relation to other composites.

Thus, restorative resin composite acts by different ways if there is variation (depth) in photo-activation and filler particle size. This phenomenon may result from the flow capacity that occurs in the network polymer that each material presents when there are changes in intensity and depth.

CONCLUSIONS

1. Each increment of condensable composite should not be greater than 2 – 3 mm and must be properly polymerized to get optimal mechanical properties.
2. Z100 and P60 composites showed higher compressive strength values, while lowest values were found for Prodigy and Solitaire.

RESUMO

O propósito deste estudo foi avaliar o efeito de técnicas restauradoras através da resistência à compressão de seis compósitos restauradores. Os compósitos (Z100, Surefil, P60, Definite, Prodigy Condensable and Solitaire) foram inseridos numa matriz circular de alumínio com 2,5 mm de diâmetro por 5 mm de altura. Cada compósito foi dividido em dois grupos (n=8): Grupo 1 – o compósito foi inserido no matriz em um incremento de 5 mm de espessura, coberto com uma tira de poliéster e fotoativado por 40 segundos; e, Grupo 2 – o compósito foi inserido em dois incrementos com 2,5 mm de espessura cada e fotoativado de maneira similar ao primeiro grupo para cada incremento. Em seguida, as amostras foram armazenadas num recipiente plástico escuro, contendo água destilada a 37º C, por 24 horas antes do ensaio. Após armazenagem, as amostras foram submetidas ao ensaio de resistência à compressão numa Instron com velocidade de 1,0 mm/minuto. O dados foram submetidos à Análise de Variância e ao teste t-student e mostraram que cada incremento do compósito condensável não deve ser maior do que 2-3 mm para ser adequadamente fotoativado e obter melhores propriedades mecânicas. O compósito Z100 e P 60 mostraram valores de resistência à compressão superiores, enquanto os menores valores de resistência foram obtidos com os compósitos Prodigy Condensable e Solitaire

UNITERMOS

Resinas compostas, compactáveis; dentística operatória; força compressiva; análise de variância

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