ORIGINAL ARTICLE

FLEXURAL STRENGTH EVALUATION OF TETRIC EVOCERAM BULK- FILL COMPOSITE IN COMPARISON WITH TRADITIONAL COMPOSITES

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ABSTRACT

Flexural strength is one of the most significant test to evaluate mechanical performance of dental restorative materials because it combines compression, tension and shear stresses. These stresses will affect the restoration during mastication in a great similarity to the real oral situation. Many brands of Bulk-fill composites are being introduced to the dental market in the last few years which enable the dentist to place a restoration of 4 mm in thickness as a single composite increment. It's important to test the flexural strength of bulk-fill composites to have an idea about their clinical performance in the oral cavity and consequently the durability of the restoration. This study was designed to evaluate flexural strength values of Tetric EvoCeram bulk-fill composite in comparison with three different traditional composites.

This study investigates the flexural strength of four different composites with A3 shade: Tetric EvoCeram Bulk fill (Ivoclar-Vivadent), Nanoceram-Bright (DMP), Ceram.X one (Dentsply), Estelite Sigma Quick (Tokuyama Dental). Ten samples from each composite material were prepared in a metal mold with dimensions of 2 mm x 2 mm x 25 mm and were photo-cured for 20 seconds. The samples were in a bar shape of the same mold dimensions. Flexural strength was evaluated by three-point bending test using universal testing machine after incubation of the samples in 37°C saline for 24 hours. Data were analyzed by one-way ANOVA and post hoc Tukey's test at 5% level of significance.

One-way ANOVA test revealed that, there was a statistically significant difference between the four composite groups being tested ($P \leq 0.05$). The highest mean flexural strength value was obtained for NANOCERAM-BRIGHT (116.75 MPa) followed by Tetric EvoCeram Bulk Fill (116.09 MPa), CERAM.X ONE (101.12 MPa) and ESTELITE SIGMA QUICK which exhibited the lowest mean flexural strength value (97.40 MPa).

It was concluded that composition of dental composite materials significantly affects their flexural strength. Composites with higher fillers content will have better flexural strength. Tetric EvoCeram Bulk Fill successfully passed the flexural strength test and can serve clinically as a successful posterior restoration.

Key Word: *Tetric EvoCeram Bulk Fill, flexural strength, Bulk-Fill, Composite Resin, Dental composites.*

INTRODUCTION

Dental composite resin is one of the most popular restorative material in dental practice nowadays. Composite fillings overcome previous amalgam fillings because they are superior in esthetic and able to be bonded to enamel and dentin.[1] There is less tooth structure loss in composite cavity preparation when compared to the placement of a similar amalgam restoration and it has been shown that there is strengthening of the remaining tooth structure after placement of composite resin restoration.[2] Composite resin has also been shown to have low cusp fracture rates in crown build up restorations.[3]

Bulk fill composite is a new evolution in dental restorative composite resin used in restorations of posterior teeth. Bulk fill composite can be applied in the cavity in thick increment (up to 4mm) and light cured once instead of incremental application of the traditional composites that need curing for each in-

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crement. This property of bulk fill composite makes it practically efficient restorative material because it makes the restorative procedure easy and more time saving than traditional composites.[4]

There are many mechanical properties that determine the quality of the restorative material. These properties include: compressive strength, diametral tensile strength, hardness, resistance to fatigue and flexural strength.

Flexural strength is one of the most significant mechanical properties of the restorative materials because in flexural strength test the tested material will be subjected to compression, tension and shear forces similar to the load found in the oral cavity.[5] One brand of bulk fill composite found nowadays in dental market is Tetric EvoCeram Bulk Fill (Ivoclar-Vivadent). The aim of this study was to evaluate and compare the flexural strength of Tetric EvoCeram bulk fill composite with three conventional composites.

METHODOLOGY

Four different composites of A3 shade: Tetric EvoCeram Bulk Fill (Ivoclar-Vivadent), Nanoceram-Bright (DMP), Ceram.X one (Dentsply), Estelite Sigma Quick (Tokuyama Dental) were selected for this study. Ten samples from each composite material were prepared (n=40). Forty bar shaped specimens were made of each composite, using a metallic mold with the dimensions specified by the ISO 4049/2000 specification[6] (25 mm x 2 mm x 2 mm). The mold was positioned over a glass slide and a mylar strip and filled with the composite material, which was inserted in a single increment. Another mylar strip was positioned and pressed against it with a glass slide for excess removal before polymerization. Woodpecker LED.B light-curing unit (Guilin Woodpecker, China) at a light intensity of 1100 mW/cm^2 with an irradiated diameter of 10 mm was used to photo-cure composite samples. Its light intensity was measured with a radiometer (SDS, Kerr, USA) before use. The composite was cured for 20 seconds in three consecutive points, producing a partial overlapping. The excess of material in the corner was carefully removed with a scalpel blade. Samples were stored in distilled water at 37°C for 24 hours before testing.

Afterwards, they were submitted to a three-point bending test with a universal testing machine (Testometric AX M350-10KN Materials Testing Machine, Rochdale, UK) with a crosshead speed of 1 mm/min. The maximum loads were obtained and the flexural strength (σ) was calculated in mega Pascals (MPa) by using the following formula:

$$\sigma = 3FL/(2BH^2)$$

where F is the maximum load (in Newton); L is the distance between the supports (in millimeters); B is the width of the specimen (in millimeters) and H, the height (also in millimeters). Data were analyzed by one-way ANOVA and post hoc Tukey's test at 5 % level of significance.

RESULTS

The mean flexural strength values and the standard deviation of the four tested groups are shown in table 1. The results of this study are summarized in Fig 1. The results indicate that the highest mean flexural strength value was obtained for Nanoceram-Bright (116.75 MPa) followed by Tetric EvoCeram Bulk Fill (116.09 MPa), Ceram.X One (101.12 MPa) and Estelite Sigma Quick (97.40 MPa) respectively.

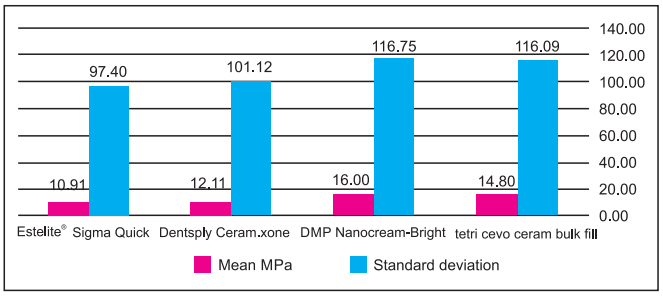

Fig 1: Bar chart showing mean flexural strength MPa and the standard deviation values of the four tested composite resins

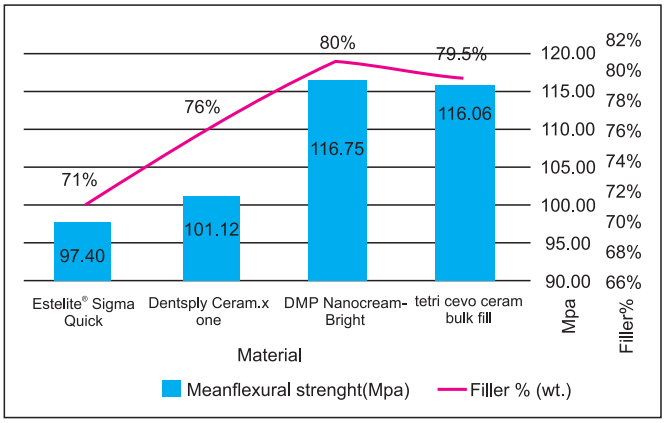

Fig 2: Flexural strength and filler wt% of the four tested composite resins

TABLE 1: MEAN FLEXURAL STRENGTH (MPA) AND THE STANDARD DEVIATION VALUES OF THE FOUR TESTED COMPOSITE RESINS

	Flexural strength	
	Mean MPa	**Standard Deviation**
Tetric Evo Ceram Bulk fill	116.09	14.80
DMP Nanoceram-Bright	116.75	16.00
Dentsply Ceram.x one	101.12	12.11
Estelite ® Sigma Quick	97.40	10.91

TABLE 2: ANOVA TEST ANALYSIS, P VALUE OBTAINED FROM ANOVA AND POST HOC TUKEY'S TEST WAS 0.003

	Sum of Squares	df	Mean Square	F	Sig. (p)
Between Groups	3013.247	3	1004.416	5.426	.003
Within Groups	6664.214	36	185.117		
Total	9677.461	39			

TABLE 3: SHOWING THE RESULTS KRUSKAL-WALLIS TEST TO DETERMINE THE STATISTICAL DIFFERENCES AMONG DIFFERENT PAIR OF GROUPS (P < 0.05)

	Paired Samples Test		Sig. (2-tailed)
Pair 1	Evoceram	DMP	.931
Pair 2	Evoceram	Xone	.019
Pair 3	Evoceram	Estelite	.002
Pair 4	DMP	Xone	.046
Pair 5	DMP	Estelite	.042
Pair 6	Xone	Estelite	.494

The P value obtained from one way ANOVA and post hoc Tukey's test was 0.003 which revealed that, there was a statistically significant difference between the four composite groups being tested in this study ($P \leq 0.05$) as shown in Table 2. Further analysis of the data was done by using Kruskal-Wallis test to determine the statistical differences among groups ($p < 0.05$) (Table 3).

The results indicate that there was statistically insignificant difference between Tetric EvoCeram Bulk Fill (Ivoclar-Vivadent) and DMP Nanoceram-Bright pair of groups ($p \geq 0.05$) as they have approximately the highest flexural strength values and there was also statistically insignificant difference between Dentsply Ceram.X One and ESTELITE SIGMA QUICK pair of groups ($p \geq 0.05$) as they have approximately the lowest flexural strength values (Fig 1).

All other pairs of groups had shown a statistically significant difference ($p \leq 0.05$). The filler loading has also an impact on the flexural strength of composite resin. As shown in Fig 2, the flexural strength increases with the increase amount of filler loading within the composite resin.

DISCUSSION

Although a new category of bulk-fill resin-based composites have been introduced, there are very few studies investigating the clinical and laboratory success of these materials. The performance of biomaterials is most often evaluated using laboratory tests.[7] Tetric EvoCeram bulk fill is one of the newly introduced bulk fill composite material in dental market and this study was oriented to determine the efficiency of this material from the point of flexural strength. Three traditional composites have been chosen to participate in this study in order to have a comparison between traditional and bulk fill composite to have a conclusion whether bulk fill composite has better flexural strength than traditional composites or not. The three-point bending test is based on the International Organization for Standardization (ISO) specification no. 4049/2000[6] for polymer-based restoratives and is widely employed in dental research.[8-10] The flexural bending test, classified as opening mode test or Mode I, is usually recommended because the specimen fabrication and the load application are quite simple.[11] Although some studies have suggested alternative flexural test designs[8,10] the three-point bending test is still the choice for evaluating composites flexural strength due to the lower standard deviation, the lower coefficient of variation and the less complex crack distribution produced by it when compared to those produced by other test designs, such as the biaxial flexural test.[8] The results of this study indicated that, the tested materials used had an adequate flexural strength ($\geq$ 80 MPa) (ISO 4049- 2009[6] and all of them can perform properly in the oral cavity as a posterior filling materials. The present study associated both the mechanical properties analyzed with the filler content percentage in weight (wt%). Although studies usually associate the mechanical behavior of composites to their filler vol%[12,13], this parameter is more complex to obtain, since it involves the previous determination of the filler density, taking into account the variation of the filler morphology and the molecular composition. Furthermore, Ferracane et al[14] found a strong correlation between the filler wt% and vol%, having chosen only one of them to correlate with the mechanical properties of the composites studied. The flexural strength mean value of Tetric EvoCeram bulk fill composite obtained from this study was 116.09 MPa and very close to the values obtained from Ivoclar-Vivadent, Scientific Documentation of Tetric EvoCeram bulk fill and Tiba et al. 120 MPa and 121.79 MPa[15] respectively. Flexural strength of DMP Nanoceram-Bright obtained from DMP: high quality dental materials, product catalogue was 138 MPa and this value is higher than its mean value obtained from this study (116.75 MPa). Dentsply Ceram.X One composite exhibited more comparable (101.12 MPa in this study) results with other two studies 120.14 MPa and 117 MPa respectively.[16,17] Dentsply: Ceram.X One scientific compendium mentioned that, Ceram.X One

flexural strength is 110 MPa and is the closest flexural strength mean value obtained that match our data (101.12 MPa). ESTELITE SIGMA QUICK composite exhibited the least flexural strength mean value in this study which was 97.40 MPa and this finding coincides with two other studies tested the same material for flexural strength mean values 108.1 MPa and 108 MPa respectively [18, 3M: Filtek Supreme Ultra Universal Restorative System manufacturer's data]. Any variation in flexural strength values of the composites being tested in this study in comparison with data obtained from other comparable studies, might be attributed to the variation in the methodology used in these studies like light curing variables or universal machine testing assembly variables. In this study, we found a direct relationship between the flexural strength values and the amount of filler loading by weight (wt%) (Fig 2). In general, the higher the filler loading, the higher the composite mechanical properties.[19] Atabek et al[20] found in their study, a comparative mechanical properties of bulk-fill resins and concluded that the composites related to the highest flexural and compressive strength values, were associated with the highest amount of filler loading. The results of this study coincides also with the findings of Julian et al[21] who observed good linear correlations of mechanical properties and filler mass fraction.

CONCLUSION

Composition of dental composite materials significantly affects their flexural strength. Composites with higher fillers content will have better flexural strength. Tetric EvoCeram Bulk Fill successfully passed the flexural strength test and can serve clinically as a successful posterior restoration.

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