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In Vitro Comparison of Microhardness of Bulk Fill Flowable Composites

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Abstract

Objectives: The aim of this study was to evaluate micro hardness of three flowable bulk fill resin composites.

Materials and methods: Surefil SDR Flow (SDR), Filtek Bulk Flow (FBF) and X-tra Base Flow (XBF) were used. 16 teflon molds were prepared for each group. The microhardness was measured on the top surfaces. The microhardness results were analyzed by ANOVA and Post Hoc Tukey test.

Results: Microhardness values differ from 22.79-33.1. XTB were found having the highest hardness and FBF had minimum hardness value.

Conclusions: Accordingly, the results of the current study indicate, it can be suggested that, XTB, SDR and XTB in clinical cases respectively.

Keywords: Bulk fill flowable composite; Microhardness; Mechanical properties

Introduction

Flowable composites were initially used in 1996. Flowable composite resins, developed to decrease polymerization shrinkage in adhesive applications where the cavity formation could not be established as required and to create a barrier to break stress, are commonly used in dentistry applications [1-3].

Since the flowable composites are compatible, consistent and easy to manipulate, their clinical use is quite high. New generation bulk fill flowable composite resins, with their increased filler ratios, could also be used as permanent restoration material due to their increasing physical and mechanical specifications. Producers specified that newly developed nano-particle composites could be utilized in thick layers, similarly with the traditional composites [4,5].

Bulk fill flowable composites are new kind resin-based composites has been recently introduced [6,7]. Flowable bulk fill composites (SDR, Smart Dentin Replacement, Dentsply Caulk, USA; Filtek Bulk Flow, 3M ESPE, USA; X-tra Base Flow, Voco, Germany) have love-viscosity and practical-use features. These materials have many favourable properties like as high flowability, small air bubbles, high flexibility, high viscosity and high filler content [8,9].

The characteristic of these new generation resin based bulf fill composites is placing 4 mm into the cavity [10]. Filler content of these composites are increased, so better mechanical properties especially hard materials were obtained [11].

In study performed previously, micro hardness of SDR, FBF were substantially below the mean values measured in the conventional composites especially microhybrid and nanohybrid composites In the same study micro hardness of XTB were found high. Hence, flowable bulk fill composite resins, like SDR, FBF require final capping layer, but XTB can be placed without final capping layer [9,12].

This study evaluated and compared three bulk fill flowable composites-concerning their micro hardness.

Materials and Methods

Three flowable bulk fill resin based composites were analyzed assigning micro hardness: SDR, (Smart Dentin Replacement, Dentsply Caulk, USA); Filtek Bulk Flow, (3M ESPE, USA); X-tra Base Flow (Voco, Germany). Product specifications are presented in **Table 1**.

4×6 mm standard teflon molds were used for bulk fill composites can be applied to the cavity at 4 mm thick and used as dentin replacement (**Figure 1**). After the composite material placed in the mold, it was pressed to create a flat surface and then 20 sec polymerized with LED device (Elip Freelight II, 3M-ESPE, St. Paul, MN, USA). Samples' upper surface were made flat with polishing machine.for correctly microhardness testing. This process was repeated for each group. 16 samples for each group; 48 samples were prepared for a total of 3 groups. The microhardness of the top surfaces were measured using a Vickers hardness tester (Esetron, ODTU, Ankara). Microindentation was carried out using a 100 mN load with a 15 seconds dwell time.

Table 1: Materials evaluated and respective manufacturer information.

Material Name	Manufacturer	Material Type	Matrix Type	Filler Content	Filler Rate %
Surefil SDR Flow (SDR)	Dentsply Caulk, USA	Bulk Fill Flowable Composite	Dimethacrylate Resin EPDMA TEGDMA Modified UDMA BHT	Silicate Glass Silicate oxide Hybrid Fiber Glass	80
Filtek Bulk Flow (FBF)	3M/ESPE St Paul, MN,USA	Bulk Fill Flowable Composite	UDMA Bis-GMA Bis-EMA Proacrilat resins TEGDMA	YBF3 Fillers Zirconia, silica particles	64.5
X-Tra Base Flow (XTB)	Voco Cuxhaven Germany	Bulk Fill Flowable Composite	Bis-GMA Bis-EMA UDMA Proxilat	Zirconia, silica particles, Ytterbium Trifluoride	75
Abbreviations: Bis-GMA: Bisphenol-A Diglycidyl Ether Dimethacrylate; Bis-EMA: Ethoxylated Bisphenol-A Dimethacrylate; EPDMA: Ethoxylated Bisphenol-A Dimethacrylate; TEGDMA: Triethyleneglycol Dimethacrylate; UDMA: Urethane Dimethacrylate; BHT: Butylated Hydroxytoluene					

Statistical analysis

The data were entered into statistical software package (IBM SPSS, V21). After the data were checked, one way ANOVA Variance Analysis were used to discuss microhardness of each material. Post Hoc Tukey Test was used for determination of the groups that make up differences. The significance level was set at $p<0.005$.

Results

Microhardness values range from 22.79 to 33.1 for bulk fill flowable composites (**Figure 2** and **Table 2**). According to the test of homogeneity of variances in the **Table 3**, significant value (0.120) was larger than 0.005 (**Table 4**), variance was homogeneous. For this reason we were used Post Hoc Tukey test for differences. Significant value (0.000) was found smaller than 0.005, and so the results of our study were positive and there were differences between the groups. Post Hoc Tukey Test was used for analyzing groups forms differ from others **Table 5**. Significant differences were found between groups. While the percentage of SDR is higher than 2.93 from FBF, lower than 6.16 from XTB. Meanwhile, the average of XTB was found higher than FBF (**Table 5**).

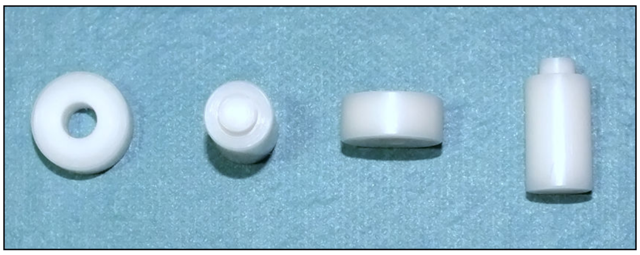

Figure 1: The 4 mm deep teflon rings with a 6 mm internal diameter hole.

Table 2: Mean microhardness for all tested materials.

					95% Confidence interval for Mean			
	N	Mean	SW. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
SDR (Surefil SDR Flow)	16	26.2356	0.6442	0.16105	258924	26.5789	25.03	27.11
FBF (Utak Bulk Flow)	16	232988	0.37288	0.9322	231001	23.4974	22.79	24.10
<TB (X-tra Base Flow)	16	324031	0.54733	0.13683	32.1115	32.6948	31.16	33.10
Total	48	273125	386956	0.55852	261889	284361	22.79	33.10

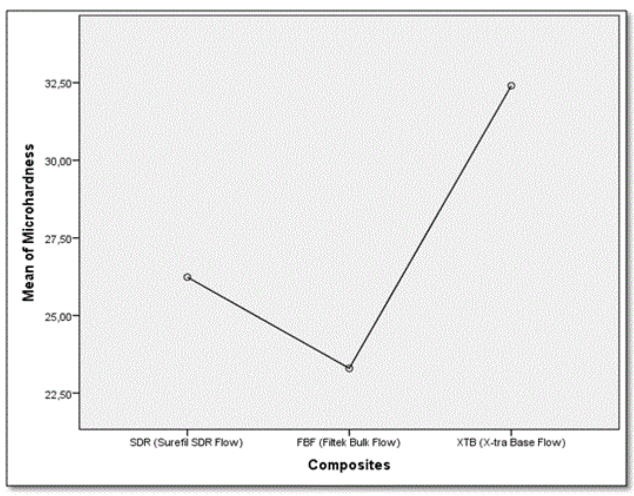

Figure 2: A chart showing the mean surface microhardness.

Discussion

Microhardness is defined as the blocking resistance that prevents the creation of permanent deformation and hardness is the most important feature contributes the success of clinical utilizations. A high microhardness value eventuates increasing the scratch and abrasion resistance, meanwhile prevents the material easily deformed against various forces [12-14].

According to a study conducted by Rouhollah et al., hardness is inversely proportional to the thickness of the composite. For this reason, the composite 2 mm thickness in each layer is proposed [14]. But in recent years due to developments in the bulk fill resin composites, the clinical fe atures high-composites are produced. We have detected in the our study, XTB is the most successful group.

Table 3: Test of homogenity of variances.

Microhardness			
Levene Statistic	df1	df2	Sig.
2.226	2	45	0.120

Table 4: Significant value.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	690.949	2	345.474	1.214.169	0.00
Within Groups	12.804	45	0.285		
Total	703.753	47			

Table 5: Post hoc tukey test results for analyzing differences between groups.

Multiple Comparisons Dependent Variable: Microhardness Tukev HSD						
(I) Composites	(J) Composites	Mean Difference (4)	Std. Error	Sig.	95% CAInfidtnCe Late	
					Lower Bound	Upper Bound
SDR (Surefil SDR Flow)	FBF (Hick Bulk Flow)	2.93688*	0.18859	0.000	24.798	33.939
	XTB (X-tta Base flow)	-6.16750*	0.18859	0.000	-66.246	-57.104
FBF (Fatek Bulklow)	SDR (Surefil SDR Flow)	-2.93688*	0.18859	0.000	-33.939	-24.798
	XTB (X-tta Base flow)	-9.10438*	0.18859	0.000	-95.614	-86.473
XTB (X-1ra Base Flow)	SDR (Surefil SDR Flow)	6.16750*	0.18859	0.000	57.104	66.246
	FBF (Filtek Bulk Flow)	9.10438*	0.18859	0.000	86.473	95.614
*The mean difference is significant at the 065 level.						

Studies demonstrate that FBF's microhardness value after 24 h Post-cure dry storage at 37°C was found as 24.0 and in our study we calculates this values as 23.29. So, It was similar that

Alshal et al. [15] in vestigated FBF's microhardness value after 24 h Post-cure dry storage at 37°C. Six bulk fill composites were used in that study. Researchers found the hardness for FBF as 24.0. However, in this study, FBF displayed similar results.

Kim et al. [8] researched the effect of resin thickness on the microhardness and optical properties of bulk-fill resin composites. They have used four differenet bulk fill composites in their study. They found microhardness of SDR at 4 mm thickness as 29.48. In our study we found this value as 26.23. Differences in the equipment used, the molds used during the preparation of the samples and the homogenous placement of the material into the molds could be effective in obtaining different results in different studies. Differences in the equipment used, the molds used during the preparation of the samples and the homogenous placement of the material into the molds could be effective in obtaining different results in different studies.

Biasi et al. [16] demonstrated microhardness and its daily clinical. This was also confirmed by Ilie et al. [17] where SDR showed the lowest surface hardness from others. However, when compared to the investigated flowable of our study, SDR flow showed higher microhardness.

Simon et al. [18] determined the Influence of increment thickness on microhardness and dentin bond strength of bulk fill resin composites. the conventional resin composite Filtek Supreme XTE (XTE) and the bulk fill resin composites SDR (SDR), Filtek Bulk Fill (FBF), xtra fil (XFIL), and Tetric EvoCeram Bulk Fill (TEBF) after 24 h storage were analyzed. Microhardness was measured at different depths. SDR showed microhardness medians of 35.5 at 4mm. In this study, this values was found as 26.23 at 4 mm thicness.

Conclusion

All tested materials showed differences. Assesment of surface hardness ratio is that, XTB were found having the highest hardness and FBF had minimum hardness value. Accordingly, the results of the current study indicate, it may be preferable in clinical cases XTB, SDR and XTB respectively.

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