

**Comparative Evaluation of Depth of Cure of Bulk Fill and Incremental Fill Composites: An In-Vitro Study**

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**Abstract**

**Aim:** To identify a composite system with maximum Depth of Cure

**Materials And Methods:** 80 samples of two bulk fill and two incremental fill composites were made (n=40 each) by using Teflon mold with a internal diameter of 6mm and thickness 4mm. Specimen were then removed from the mold and stored at room temperature in light proof container for 24 hours. Then the top and bottom Vickers Hardness was determined by Vickers Hardness Machine with load application of 200 grams.

**Results:** Incremental Fill Composites (Spectrum TPH and Charisma Classic) showed greater Depth Of Cure than the Bulk Fill Composites (SureFil and SonicFill).

**Conclusion:** Depth of cure was greater in incremental fill composites than Bulk fill composites.

**Keywords:** composites, bulk fill, incremental fill, depth of cure

**Introduction**

Light cured composites are the material of choice for direct restorations because they offer prolonged manipulation time and on command curing.<sup>1</sup> Composite has shown a level of success as a restorative material. Even so, complications related to polymerization shrinkage stress and curing depth still cause significant

reluctance to use them There have been continuous efforts to improve its physical and mechanical properties and the operating techniques used to apply it.<sup>2</sup> The depth of cure is an important parameter regarding the clinical success of light polymerized composite resins. The depth of cure can be affected by several factors associated with the source of light energy including the spectral wavelength distribution, intensity, exposure period and distance from the material.<sup>3</sup>

Resin-based composites comprising 50% of direct posterior restorations and 95% of direct anterior restorations,<sup>4</sup> the demand for improved mechanical properties has encouraged further investigation and development of these materials. The material placed incrementally and cure 2 mm layers of the material is one of the advantage of resin based composites;<sup>5-8</sup> however, bulk-fill composites which were recently developed have demonstrated measurement of 4mm depth of cure.<sup>9-13</sup> The polymerization of a dental composite is the underlying source of its hardness, strength, wear resistance, and prevention of monomer elution.<sup>14</sup> The leading causes of composite restoration failure are the bulk fracture and recurrent caries,<sup>15</sup> and if there is decreased DOC which

will further lead to inadequate physical properties that can ultimately lead to clinical failure.<sup>16</sup>

Bulk materials are recommended for insertion in a maximum 4-mm bulk due to their high reactivity to light curing. The rationale of the bulk-fill resins is to reduce clinical steps by filling the cavity in —single| increment, leading to a reduced porosity and a uniform consistency for the restoration, this will reduce the clinical time taken and also the cost. At present, three types of bulk-fill resins are available, distinguished primarily by their viscosity, which is Low, for example, Smart Dentin Replacement SDR, Venus Bulk Fill, Medium for example Tetric Evo ceram Bulk Fill, QuixFil, X-Tra Fil (Voco, U.S.A), or Fluctuating, for example, SonicFill and fiber- reinforced bulk-fill composite, for example, Ever X flow.<sup>17</sup>

Recently, a novel composite delivery system together with a new, proprietary composite formulation has been introduced. This restorative system, SonicFill, uses sonic energy for insertion of composite resin into posterior teeth preparations employing one bulk increment causing initial decreased viscosity of the composite for increased flowability into the cavity preparation.<sup>18</sup>

**Materials and Method**

Teflon molds were used to make the samples for Depth of Cure. Teflon mold were prepared with an internal diameter of 6mm and thickness of 4mm. The depth of cure of the materials was assessed according to the International Organization of Standard. The mold was placed on a clear glass slab and then composite for the respective group was filled and covered with mylar matrix and made flat by pressing down with glass slab Specimen (n=80) were prepared out of four materials and divided into the respective 4 groups(n=20 in each group)

Group A (N=20): Sure fill

Group B (N=20): Sonic fill

Group C (N=20): Spectrum Tph

Group D (N=20): Charisma Classic

The Specimen were light cured for 20s . Specimen were then removed from the mold and stored at room temperature in light proof container for 24 hours. A load application of 200 grams was done. For each specimen, three Vickers Hardness Number readings were recorded for the Top and Bottom surface respectively..The results were calculated, tabulated and subjected to Statistical Analysis

**Results**

The depth of cure was higher in incremental fill composites than bulk fill composites.

Table 1: Mean and Standard Deviation of Top Surface of all samples of all groups

Groups	N	Mean	Std. Deviation
Gr A	20	62.7159	6.9742
Gr B	20	64.1937	5.6225
Gr C	20	72.7915	4.5305
Gr D	20	69.0382	3.5020
F value, p <sup>c</sup> value	15.047, <0.0001		

Table 2: Post hoc pair wise comparison of Depth of Cure using Post hoc Tukey’s test for top surface.

	Gr A	Gr B	Gr C	Gr D
Gr A	-	0.816, NS	<0.0001, S	0.002, S
Gr B	0.816, NS	-	0.001, S	0.026, S
Gr C	<0.0001, S	0.001, S	-	0.124, NS
Gr D	0.002, S	0.026, S	0.124, NS	-

Table 3: Mean and Standard Deviation of Bottom Surface of all samples of all groups

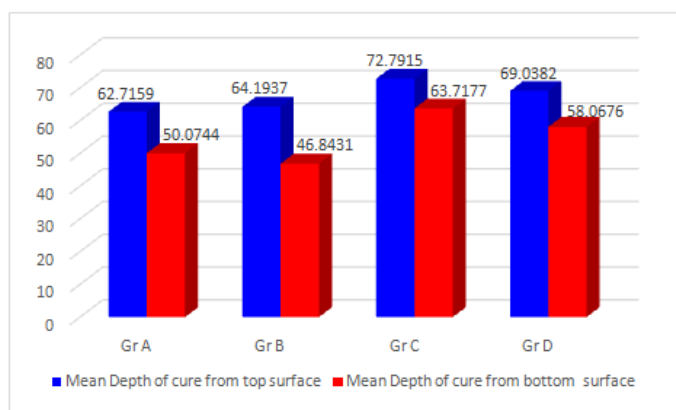
Groups	N	Mean	Std. Deviation
Gr A	20	50.0744	6.63226
Gr B	20	46.8431	3.65418
Gr C	20	63.7177	5.56837
Gr D	20	58.0676	3.65804
F value, p <sup>c</sup> value	46.079, <0.0001		

Table 4: Post hoc pairwise comparison of Depth of cure using Post hoc Tukey’s test for bottom surface.

	Gr A	Gr B	Gr C	Gr D
Gr A	-	0.188, NS	<0.0001, S	<0.0001, S
Gr B	0.188, NS	-	<0.0001, S	<0.0001, S
Gr C	<0.0001, S	<0.0001, S	-	0.004, S
Gr D	<0.0001, S	<0.0001, S	0.004, S	-

S-Statistically Significant, NS – Not Statistically significant

Graph 1: Comparison of Mean Depth of Cure from Top Surface with Mean Depth of Cure from Bottom Surface.



### Discussion

Self-cured traditional composites which were prepared as two components mixed just before use, resulting in inadvertent air incorporation leaving pores as mechanical defects that were extremely deleterious to strength.<sup>19</sup> Adhesive bonding to tooth structure has been an integral part of modern restorative dental practice that obviously improves the biomechanical and esthetic quality outcomes of restoration.<sup>20</sup> An effective bonding to tooth structure would durably seal dentinal tubules and restorative margins.<sup>21</sup> Different resin adhesives, placement techniques, and resin composite materials have been suggested to improve the clinical reliability and to control the effect of polymerization contraction stresses Shrinkage stresses that develop at tooth-restoration interfaces interfere with effective adhesive bonds to tooth structure and marginal sealing of direct composite restorations.<sup>22</sup>

Incrementally placed composite resins came, but the big challenge faced by them was the, bond failures between increments, incorporation of voids or contamination between composite layers, because of limited access in conservative preparations leads to difficulty in placement, and the increased time required to place and polymerize each layer.<sup>23</sup>

Then came bulk fill composites which were having less incorporation of voids between composite layer than any other composite placement technique, require less chair side time thus making the restorative process comfortable to the patient.

This study was performed to check the depth of cure of bulk fill and incremental fill composites from top and bottom surface.

### For Top Surface

The mean score values for Depth Of Cure for Group A was 62.7159VHN, Group B was 64.1937VHN, Group C was 72.7015VHN, Group D was 69.0382VHN and Standard Deviation for Group A was 6.9742, Group B was 5.6225, Group C was 4.5305 and Group D was 3.5020 respectively (Table 1).

When intergroup comparison of Mean Depth Of Cure from Top Surface was done using One Way ANOVA test, then the difference was found to be Statistically Significant between all Groups having the p value <0.0001 (Table 1).

Post hoc pairwise comparison of mean Depth Of Cure from Top Surface among four study groups using Post hoc Tukey’s test and it was found that the Mean Depth Of Cure among Group A and B was significantly lesser than that of Group C and D samples. The difference in the Mean Depth Of Cure of Group A and Group B was not found to be Statistically significant. The difference in the Mean Depth Of Cure of Group C and Group D was not found to be statistically significant (Table 2).

In Table 2 when Post hoc pairwise comparison was done using Post hoc Tukey's test and the following was found:

1. When Group A was compared with Group B the values were Statistically Nonsignificant.
2. When Group A was compared with Group C and Group D the values were Statistically Significant.
3. When Group B was compared with Group C and Group D the values were Statistically Significant
4. When Group C was compared with Group D the value was found Statistically Non –significant

The results showed that the maximum Depth Of Cure was found in Spectrum TPH and Charisma Classic composite, indicating that the Incremental Fill composites have higher Depth Of Cure than the Bulk Fill composites which are Surefil and Sonic Fill.

#### **For Bottom Surface**

The mean score values for Depth Of Cure for Group A was 50.0744VHN, Group B was 46.8431VHN, Group C was 63.7177VHN, Group D was 58.0676VHN and Standard Deviation for Group A was 6.63226, Group B was 3.65418, Group C was 5.56837 and Group D was 3.65804 (Table 3).

When intergroup comparison of Mean Depth Of Cure from Bottom Surface was done using One Way ANOVA test, then the difference was found to be Statistically Significant between all Groups having the P value <0.0001 (Table 3).

Post hoc pairwise comparison of mean Depth Of Cure from Bottom Surface among four study groups using Post hoc Tukey's test and it was found that the Mean Depth Of Cure among Group A and B was significantly lesser than that of Group C and D samples. The difference in the Mean Depth Of Cure of Group A and Group B was not found to be Statistically significant. The difference in the Mean Depth Of Cure of Group C and Group D was not found to be statistically significant (Table 4).

In table 4 when Post hoc pairwise comparison was done using Post hoc Tukey's test and the following was found:

1. When Group A was compared with Group B the values were Statistically Nonsignificant.
2. When Group A was compared with Group C, D the values were Statistically Significant.
3. When Group B was compared with Group C and Group D the values were Statistically Significant
4. When Group C was compared with Group D the value was found Statistically Non –significant

The results showed that the maximum Depth Of Cure was found in Spectrum TPH and Charisma Classic composites, indicating that the Incremental Fill composites have higher Depth Of Cure than the Bulk Fill composites which are Surefil and Sonicfill.

#### **When Top and Bottom Surfaces for Vickers Hardness Test were compared it was found:**

1. When Top Surface of Group A was compared with Bottom Surface of Group A the values were Statistically Significant.
2. When Top Surface of Group B was compared with Bottom Surface of Group B the values were Statistically Significant.
3. When Top Surface of Group C was compared with Bottom Surface of Group C the values were Statistically Significant.
4. When Top Surface of Group D was compared with Bottom Surface of Group D the values were Statistically Significant (Graph 1).

The Vickers Hardness Test showed higher Hardness of all the Top Surfaces of Group A,B,C,D which was Statistically Significant of all the Bottom Surfaces.

When Depth Of Cure was compared from Top Surface to Bottom Surface the following was found: **Top Surface > Bottom Surface**

Many studies were done earlier to check the depth of cure of various composites. According to **Y A Abed et al**<sup>24</sup> the highest VHN value was obtained for the Incremental Fill Composites in comparison to that of Bulk Fill Composites. Several factors related to composition were reported to affect the Surface Hardness of resin composite restorative materials. It was reported that, mass fractions, size and distribution of filler particles have a significant effect on some physical and mechanical properties, including Depth Of Cure.

According to **Leprince et al**<sup>25</sup> incremental Fill Composites have highest VHN than Bulk Fill Composites. They mentioned that other parameters such as particle size, degree of polymers crosslinking and photoinitiators seem to have a significant influence on Surface Hardness. They also mentioned that the increased VHN value of the Incremental Fill Composites compared to that of Bulk Fill Composites, either for Top or Bottom surface, it might be related to the more total energy delivered to the Incrementally Filled Composites.

But according to **Benetti AR et al**<sup>26</sup> Bulk Fill Composites have improved Depth Of Cure when compared with the Conventional Fill Composites and it was due to the improvements in their initiator system and increased translucency.

### Conclusion

The following conclusions were drawn:

- Incremental Fill Composites (Spectrum TPH and Charisma Classic) showed greater Depth Of Cure than the Bulk Fill Composites (SureFil and SonicFill).
- Among the Incremental Fill Composite Groups, there was no Statistically Significant difference in the Depth Of Cure for both Groups.
- When the Depth Of Cure Top Surface and Bottom Surface was compared the Top Surface showed a greater Depth Of Cure.

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