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Comparative Evaluation Of Flexural Strength Of Two Commercially Available Bulk Fill Composite Restorative Materials

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ABSTRACT

Aim: The aim of this study is to comparatively evaluate the flexural strength of two commercially available bulk fill composites (SDR Flow+ and ColteneFill up)

Materials and methods: Ten bar shaped specimens were fabricated for each material (SDR Flow+ and Coltene Fill up) measuring 25 x 2 x 2 mm. All the specimens were subjected to thermocycling for 500 cycles at 5-50 degree celsius temperature with a 30 second dwell time at each temperature. All the specimens were loaded until fracture in a universal testing machine (INSTRON) and the values obtained were tabulated and statistically analyzed using Mann Whitney U test.

Results: The SDR group showed a higher mean flexural strength (42.50 MPa) than Coletene Fill up and this was statistically significant ($p<0.05$).

Conclusion: This study concluded that SDR Flow has a higher flexural strength than Fill up composite.

Keywords: *Flexural strength; Bulk fill composite; Fiber reinforced composite*

INTRODUCTION

Dental caries is an infectious disease that causes deterioration of inorganic and organic tissues that must be removed and replaced with a suitable restorative material to cease disease progression (1). The indications for resin-based composites (RBCs) have grown with developments in materials science and clinical techniques to include significant posterior stress-bearing restorations that were previously restored with amalgam.(2)(2,3). However, due to the incremental gradual layering technique and problems in depth of cure, posterior RBC restorations continue to remain technically challenging (4)(5)(5,6)(7). The incremental layering technique is a basic requisite for resin-based composite restoration. For conventional light-activated composites, incremental filling is recommended, wherein increments no thicker than 2 mm are inserted and photoactivated. This protocol accomplishes two goals: reduction in polymerization stress and a uniform degree of conversion throughout the material thickness (8) Lesser the degree of conversion, higher is the monomer proportion in the restoration.

This could result in postoperative sensitivity and result in the composite filling failing prematurely. To circumvent these disadvantages, new bulk fill composite materials have been introduced. Because of the increased depth of cure obtained by expanded filler sizes and a reduced number of pigments, these bulk-fill RBCs may be applied in thicker increments of up to 4mm.(9–11)(12).It could reduce the working time to approximately half of that in the conventional composite. As a result, manufacturers promote the bulk-filling technique as being faster than the incremental technique.

Because of their improved mechanical properties and wear resistance, as well as their lower cost, resin composites have now become the material of choice for many dentists not only for dentine replacement but also for the restoration of the entire posterior tooth . One of these attempts has been to use short fiber-reinforced composite (SFRC) as a dentin-replacing material (bulk core) or as a post-core base under a surface layer of enamel-replacing material (PFC) in biomimetic bi-structured composite restorations.(13)(14)(15)(15,16)

Composite restorations can be subjected to significant flexural stresses in both anterior and posterior teeth clinically. Flexural property characterization (strength and modulus) is hence essential for clinicians and material scientists. Flexural strength is defined as the failure stress of a material as measured in bending (17,18)(19). Flexural strength has been shown to be a more distinguishing test than compressive strength and more sensitive to subtle changes in a material's substructure (20)(20,21)(22).

SDR Flow+ (SDR) Dentsply-Sirona, Milford, USA (180511) contains modified UDMA, TEGDMA, EBPADMA, Barium borosilicate glass 68 wt%, 44 vol%. SDR technology enables the formation of a more relaxed network, minimizing the build-up of stress. This reduces the risk of gap formation during polymerization and also SDR flowable bulk fill technology fills and easily adapts to the cavity, flowing into every area throughout the preparation to provide excellent cavity adaptation during placement. Advantages of SDR Flow+ are excellent adaptation, low shrinkage stress and good flow.

Fill-up (coltene) is a dual cure, medium viscosity bulk fill composite and contains TMPTMA, UDMA, bis-GMA, TEGDMA, dibenzoyl peroxide, benzoyl peroxide, Zinc oxide coated. 65 wt% filler load; 49 vol% filler load. Concerns about the mechanical properties of strength over traditional RBC were raised by a dual cure content.

To our knowledge, no research has been published that evaluates the flexural strength of the above mentioned bulk fill composites. The aim of this in vitro study was to assess the flexural strength of two commercially available bulk fill composites (SDR Flow+ and ColteneFill up). The null hypothesis states that there would be no significant difference in flexural strength between the two materials.

MATERIALS AND METHODS

Specimen preparation

Two bulk fill composites namely SDR Flow+ (Dentsply-Sirona, USA) and Fill up! (Coltene, USA) were used in this study. The samples were divided into two groups of 10 samples each based on the material used.

Group 1 : SDR Flow+ (Dentsply-Sirona, USA)

Group 2 : Fill up! (Coltene, USA)

Using custom stainless-steel molds, bar shaped test specimens (16x2x2 mm) of each of the RBCs were fabricated. The molds were injected with flowable composite materials. By compressing the molds between two Mylar strips with glass slides, excess material was removed. With two alternating irradiations of 10 seconds each, the top surface of the specimens were light polymerized through the glass slide using a calibrated LED curing light (Woodpecker Light cure LUXE Plus). The specimens were light cured for another 10 seconds after the glass slides were removed. After that, the Mylar strips were discarded, and the composite beams were taken out of their molds. Fine polishing discs (Shofu Super-snap) were used to gently polish any minor material excess, or ‘‘fins” The composite specimens were visually inspected for voids, and those that were found to be faulty were replaced. A digital caliper was used to check the specimens' final dimensions and the parallelism between their opposite surfaces.

Thermocycling

The specimens were kept dry in the dark for 24 hours at 37 degrees Celsius (i). All the specimens

were subjected to 500 thermal cycles at temperatures ranging from 5 to 55 degrees Celsius with a 30-second dwell time at each temperature.

Flexural testing

All the specimens were loaded until fracture in a universal testing machine (INSTRON) with a load cell of Maximum force (N) and a crosshead speed of 0.5 mm/min and the mean flexural strength was calculated.

Statistical analysis

The mean flexural strength values obtained were statistically analyzed in the SPSS software Version 23.0 using Mann Whitney U test. The level of significance was set at $p<0.05$.

RESULT

The SDR Flow group showed a statistically significant higher mean flexural strength (42.50 MPa) than the Coletene Fill up! group (12.74 MPa) (Figure 1 and Table 1).

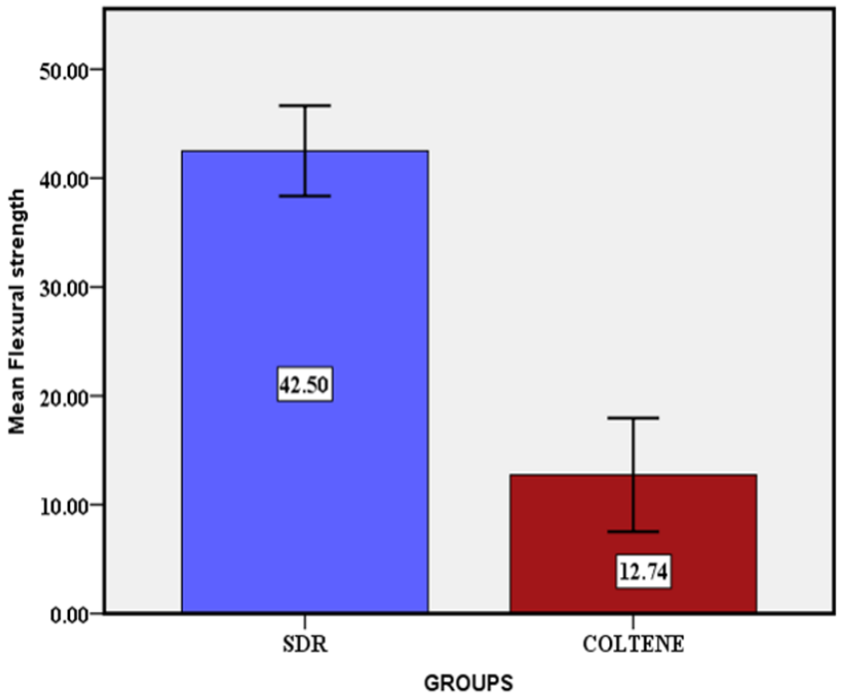

FIGURE 1: Bar graph showing the mean flexural strength of SDR and Coltene groups. SDR showed a higher mean flexural strength (42.50 MPa) than Coltene (12.74 MPa) group.

TABLE 1: Comparison of mean flexural strength (MPa) values of both groups using Mann-Whitney U test.

GROUPS	Mean	Std. Deviation	Minimum	Maximum	Mann-Whitney U test value	P value
SDR	42.50	4.15	37.80	45.70	0.001	**0.05***
COLTENE	12.74	5.22	8.44	18.55		

*Indicates significance

DISCUSSION

In the current study, before flexural testing in a universal testing machine, all the samples were subjected to thermocycling. The purpose of thermocycling is to subject the specimens to aging in a brief amount of time by simulating the thermal stress which dental restorations and other materials would be subject to (23)(23,24)(25). Flexural testing is often used to characterize RBCs because they decide both flexural modulus and stiffness toughness (26)(27)(28). Flexural strength refers to the maximum stress that RBCs can withstand before failing and flexural modulus describes the stiffness of RBCs. RBCs with high flexural properties are typically chosen in class I, II, III, and IV cavities to minimize fracture or deformation under high occlusal forces, while RBCs with low flexural modulus are preferred in class V cavities because they can flex with the teeth during function and parafunction, reducing stresses at the adhesive interface and decreasing the chances of debonding. (26,29)(30)(31)(32).

The specimen was created using two different bulk fill composites and an artificially created stainless steel mold (16x2x2 mm). To ensure that all of the composite specimens were the same size, a mold was used. For smoothness and to avoid irregularities, glass slabs were placed above and below the stainless steel mold.

Flexural strength was found to be lower in flowable bulk fill composites when compared to conventional bulk fill composites(17)(33)(33,34)(16). When compared to fill up flowable bulk fill composite, universal testing machine test samples show that SDR flow+ has a high flexural strength. In a previous study, SDR flow+ exhibited extremely low polymerization stress until gelation. SDR achieved the lowest Vickers hardness,the highest modulus of elasticity, the highest creep and showed the significantly lowest elastic deformation. SDR flow+ showed the highest polymerization at 4 mm bulk thickness with bottom-to-top hardness ratios above 90%(35)(36)(37).

In the oral environment, the resin based materials are subjected to a wide array of stresses and temperature changes that can affect the integrity of the material. This is simulated in the in vitro set up with thermocycling. These intra oral stresses can lead to resin dissolution, filler exposure and dislodgement may result in RBC weakening (38)(39)0)(40). To improve the clinical longevity of composite restorations, patients' dietary habits should be considered during material selection.(41)(42)(43)(44)(7)

In some ways, the current study could be improved. The current study's static flexural (22,44)testing cannot provide insights into material structure because dental RBCs are viscoelastic in nature and exhibit both viscous and elastic characteristics when deformed. To better assess the viscoelastic properties of RBCs, dynamic testing with dynamic mechanical analysis needs to be performed.(45)(12,42,46). Even if the current report's findings are promising, additional in vivo studies are required to confirm the findings.

Our team has extensive knowledge and research experience that has translate into high quality publications (47–56)

CONCLUSION

This study concluded that SDR Flow has a higher flexural strength than Fill up composite. Further studies are needed to evaluate the clinical performance of both these materials under different circumstances.

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