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FLEXURAL STRENGTH AND DEPTH OF CURE OF SONIC FILL RESIN COMPOSITE

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ABSTRACT

Aim: This research was designed to evaluate the flexural strength and depth of cure of Sonic Fill resin composite at different storage times. ***Materials and methods:*** Two Bulk-fill composites (Sonic fill, kerr; X-tra fill, Voco) and one incremental-fill composite (Herculite XRV, kerr) were used. For Flexural strength (FS) 45 Bar-shape specimens have created through mini flexural mold with specific diameters has: (2mm width ×2mm depth×12mm length) Using Teflon molds. The mold was filled with all resin composites material. FS was determined using the three-point bending test in a universal testing machine. For depth of cure (DOC) a 90 human molars, free from caries, extracted for pathologic reasons were collected to be used in this study. Standardized box-shaped cavity preparations were prepared on both proximal surfaces of each tooth with cavity depth of 2 and 5mm. Specimens were stored in artificial saliva in dark at body temperature (37±1) for one day, one month and three months before testing. (DOC) was determined using the Vicker's microhardness test for one half of the specimens on top and bottom surfaces of each specimen. Data for FS and DOC were analyzed by ANOVA and pair-wise Newmanekeuls test. ***Results:*** It was found that the highest mean value of FS was recorded for sonic fill composite group at one month storage time, while the lowest mean value was recorded for Herculite XRV composite group at three months as indicated by two way ANOVA test. Pair-wise Tukey's post-hoc test showed no-significant between one month and three month storage. Also it was found that DOC mean values of X-tra fil composite group recorded statistically significant highest B/T ratio mean values at one month storage time followed by sonic fill composite group at one month, while the lowest statistically significant B/T ratio mean Values were recorded for Herculite XRV composite group at three months, as indicated by two way ANOVA tests. Pair-wise Tukey's post-hoc test showed no-significant between one day and three months storage time subgroups. ***Conclusion:*** It can be concluded that sonic full composite with special designed unique activated - system (hand-piece with unidose - tip) is considered better bulk -fill composite material that used in posterior restoration. Differences in FS and DOC values among materials proved to be a material dependent.

INTRODUCTION

Resin-based composites have been successfully used in dentistry for many years and widely replaced amalgam as posterior restorations Dental composites are expected to have mechanical properties comparable to those of tooth enamel and dentin and provide a long life of service However, several factors limit the performance of composite, especially depth of cure and degree of conversion ([1].

Historically, the maximum incremental thickness with conventional resin composite was 2mm. However, restoring deeper preparations with 2mm increment is time consuming and relatively technique sensitive. Recently, a new class of resin-based composite, called "bulk-fill "resin composites have been introduced with the purpose of time and thus cost savings [(2)].

Depth of cure testing used to assess the maximal increment thickness of resin composites.[(3)] Energy of the light emitted from a light-curing unit decreases drastically when transmitted through resin composite, leading to a gradual decrease in degree of conversion of the resin composite material.

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Decreases in degree of conversion compromise a physical properties and increases elution of monomer [4] and thus may lead to premature failure of a restoration or may negatively affect the pulp tissue.

Flexural strength testing was chosen since it possesses a direct clinical correlation and great predictive value for the success of a material in practice. It is a mechanical property that should be considered when the restoration subjected to high masticatory force [5].

Sonic Fill system was recently introduced into the market, it is indicated for use as a bulk fill posterior composite restorations and can be bulk filled in layers up to 5 mm in depth due to reduced polymerization shrinkage. It incorporates a highly-filled proprietary resin with special modifiers that react to sonic energy. As sonic energy is applied through the hand piece, the modifier causes the viscosity to drop (up to 87 %) increasing the flow ability of the resin composite, enabling quick placement and precise adaptation to the cavity walls. When the sonic energy is stopped, the composite returns to a more viscous, non-slumping state that is good for carving and contouring [6].

MATERIALS AND METHODS

1. **Selection of teeth for DOC:** A total 90 freshly extracted human molars were selected. Each tooth was embedded vertically in the specially fabricated cylindrical acrylic mold to the level of the cemento-enamel junction of the tooth.

2. **Mold fabrication for FS specimens**: A 45 Bar-shape specimens have created through mini flexural mold with specific diameters have: (2mm width ×2mm depth×12mm length) to be used for measuring Flexural strength of tested materials. Using Teflon molds, which is consist of two equal pieces of Teflon which they adapt to each other to form the mold. The two pieces were fixed and supported to each anther with a plastic frame.

Grouping of specimens:

A. Grouping of specimens for FS: 45 Bar-shape specimens were divided into 3 main groups (30 specimens each) according to the composite material (M); (group A) for sonic fill, (group B) for X-tra fil and (group C) for Herculite XRV composite. Each group was subdivided into three equal subgroups (5 specimens each) according to storage times(S) (5 specimens each) one day, one month and three months.

B. Grouping of specimens for DOC: The teeth were divided into 3 main groups (30 teeth each) according to the composite material (M); (group A) for sonic fill, (group B) for X-tra fil and (group C) for Herculite XRV composite. Each group was subdivided into 2 equal subgroups (15 teeth each) according to the cavity depths(D), 2mm and 5mm depth. Each subgroup was farther divided into three equal divisions according to storage times(S) (5 teeth each) one day, one month and three months. Then each adhesive agent was applied according to manufacturer instructions, then bulk fill composite resin was packed as one layer while was placed in increments for incremental composite resin. The specimens were cured using elipar curing unit following manufacturer instructions. The specimens were stored in artificial saliva at (37±1) for one day, one month and three months before testing. The specimens were sectioned mesio-distally by using IsoMet 4000 microsaw device to produce buccal and lingual halves. Then the DC was assessed by using a Fourier transform infrared spectroscopy) FTIR), while VHN at top and bottom was assessed by using a vicker hardness testing machine.

RESULTS

It was found that sonic fill composite group recorded statistically significant highest flexural strength mean values followed by x-tra fill composite group while the lowest statistically significant

Flexural strength mean values was recorded for Herculite composite group, also it was found that one month storage time subgroups recorded statistically significant highest flexural strength mean values followed by one day storage time subgroups mean values while the lowest statistically significant flexural strength mean values recorded after three months storage time subgroups(fig. 1) as indicated by two way ANOVA test. Pair-wise Tukey's post-hoc test showed no-significant between one month and three month storage. It was found that DOC mean values of X-tra fil composite group recorded statistically significant highest B/T ratio mean values at 2mm and 5mm followed by sonic fill composite group while the lowest statistically

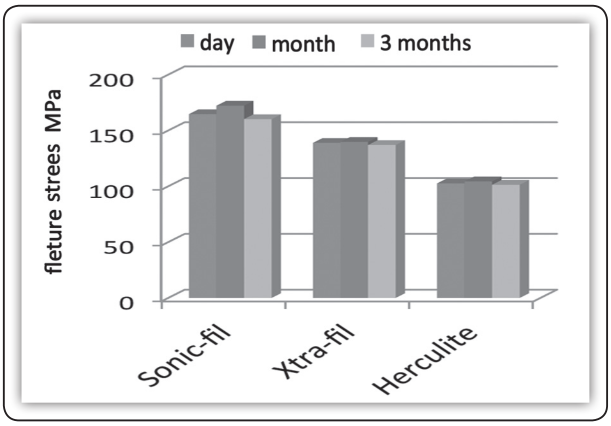

Fig. (1); Column chart of FS mean values as function composite group and storage time.

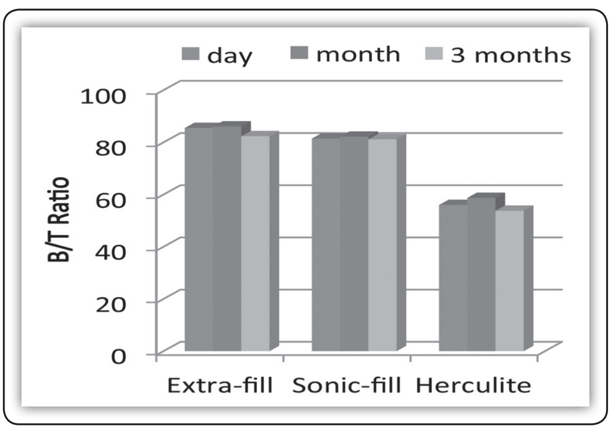

Fig. (2) Column chart of the mean values of B/T ratio for different storage times with all dental composite resin at 5 mm.

significant B/T ratio mean values was recorded for Herculite composite group (fig. 2). It was found that one month storage time subgroups recorded statistically significant highest B/T ratio mean values followed by one day storage time subgroups mean values while the lowest statistically significant B/T ratio mean values recorded after three months storage times subgroups as indicated by two way ANOVA test. Pair-wise Tukey's post-hoc test showed no-significant between one day and three months storage times subgroups.

DISCUSSION

A new resin based composite (RBC) material class, the bulk-fill RBCs, has been introduced in the past few years. There is an attempt to speed up the restoration process by enabling up to 4- or 5-mm thick increments to be cured in one step, thus skipping the time-consuming layering process [7].

A. Effect of sonic fill resin composite on FS: The results of the present study revealed that, Sonic-fill composite group recorded statistically significant highest flexural strength mean values followed by X-tra fil composite group while the lowest statistically significant flexural strength mean values was recorded for Herculite composite group. All material record flexural strength more than 80 MPa, accordingly our results showed that, all of the tested materials exhibited high flexural strength and can be used in occlusal areas, thus, an additional final capping layer is not necessary. This result may attributed to an increase the content (sonicFill 83.5% wt), (X-trafil 86% wt), (Herculit XRV79% by wt) and the hybrid size of filler particles (sonicFill and Herculit XRV were nanohybrid type), (X-trafil was multihybrid type), of the fillers of the discussed materials which may affect physical and mechanical properties of composite resins.

The results of the flexural strength of this study was in agreement with, Ilie, et al. [8)] Bayraktar Y, [(9)]

Attar, N.[10] and Didem A,[11] who found that all materials analyzed fulfill the ISO 4049 criteria (flexural strength ≥80MPa) to be used in load bearing areas as restorative materials.

The sonic fill is higher might be attributed to SonicFill is an injectable resin composite and sonic energy lowers its viscosity during its application, which behave as a flowable composite and therefore it could play a role in the possibility of decreasing the voids between layers, concomitant with higher filler loading from nano-hybrid type, and according to the manufacturer instructions, the difference in depth of cure between the two tested materials. It was reported that SonicFill had a higher depth of curing (5 mm) compared to conventional composites and other bulk fill which needed an incremental packing with a maximum of 4 and 2 mm thickness respectively.

The results of the flexural strength of this study came in agreement with Ibarra et al. [12] who compared the physical properties of SonicFill bulk fill resin composite material to other different bulk fill materials showed SonicFill had a statistically significant higher flexural strength values compared to the other bulk fill resin composite materials tested in that study

B. Effect of sonic fill resin composite on DOC: The results of the present study for the top and bottom surface microhardness at 2 and 5mm showed that the x-tra fil resin composite had the highest mean value followed by sonic fill resin composite while the lowest mean value was recorded for Herculite XRV Ultra resin composite. Non-significant difference was founded between bulk fill materials, while there was a significant difference between bulk fill materials(X-tra fil, sonic fill) and incremental fill (Herculite XRV). Regarding to the material type the difference in the top and bottom surface microhardness values for the materials tested might be attributed to several factors related to material composition that reported to affect the surface hardness of resin composite restorative material. It was reported that, mass fractions, size and distribution of filler particles have a significant effect on some physical and mechanical properties. [13,14].

X-tra fil has higher microhardness value over sonicFill. SonicFill presents the most irregular shaped fillers when compared to X-tra fil, which is a factor known to lead to reduced translucency. [15] Also the difference between polymerized and unpolymerized materials was low in SonicFill material indicating less changes in the matrix during polymerization or a mismatch between the refractive indices at the matrix-filler interface.[16] It was also reported that fillers with sizes approaching half of that wavelength used for irradiation showed increased scattering. [17] Therefore, the light scattered by Nano-fillers would adversely affect the physical properties of Nano-filled composite materials. [18] . The larger particles of hybrid composites have a greater depth of cure as they less affected by light scattering [19].

Also, the presence of amine groups in the urethane structure of UDMA monomer is responsible for the characteristic chain transfer reactions that provide an alternative path for the continuation of polymerization. These reactions result in increased mobility of radical sites on the network and consequently enhanced polymerization and monomer conversion This explains the increased microhardness of X-tra fil (containing UDMA) when compared to that of Bis-GMA, EBPADMA containing organic matrix of sonicFill [20].

C. Effect of storage time on FS and DOC: This study showed at one month the depth of cure and flexural strength of bulk fill and conventional composite was increased. This was may be attributed to the continuation of the polymerization process in composite resin at a slow rate, due to existence of free radicals in the polymer network which remain capable of reacting with remaining double bonds and continuing polymerization. Also, may be attributed to a progressive increase in cross linking in addition to post- irradiation polymerization reaction [21].

These results were in agreement with Baue rand ilie) [22] who found that aging in saliva produced a positive effect on micro-mechanical properties of composites. Also, the results were in agreement with Tornavoi et al.) [23] and who observed better mechanical properties after aging for materials with smaller particles and greater percentage by volume.

These results were in disagreement with Iwami H.[24] and Biradar B. [25] ,who found more than 90% of the water absorption occurred in the first week ,which affected on the physical and chemical properties. The cause of this result was to the difference in storage media, because this results use the water as storage medium. While in our result we used the artificial saliva.

This study showed gradual decrease in depth of cure and flexural strength from one month to three months storage. This was may be attributed to the absorption of water which occurs mainly as direct absorption by the resin matrix due to hydrophilic/hydrophobic nature of the resin matrix which decrease the life of a composite resin by plasticizing and expanding of the resin, this lead to discoloration and decrease depth of cure.

The result of this study showed agreement with (Curtis A et al. [26] and Medeiros S. [27] who found that the increase water uptake for composite resin may be attributed to the larger surface area to volume ratio of the fillers present in the materials. Also tend to increase the water uptake and resultant degradation of the filler/matrix interface.

Also, this study showed agreement with Musanje L. [28] who found that the water sorption decreased the values of mechanical properties of resin composite due to plasticizing and hydrolytic degradation of monomer which is diffusion –rate dependent process influenced by type of polymer, filler particle type and surface treatment used. The absorbed water may also react with the coupling agent resulting in the failure of the filler –matrix bond .Thus leaching of monomer from the composite into the oral environment and water replacement to fill the holes left by eluting monomers or oligomers might have contributed to the more weakening effect.

For flexural strength, the sonicFill composite had the highest mean value, followed by the x-trafil resin composite, while the lowest mean value Herculite XRV Ultra resin composite. This result may be attributed to the complete adaptation of the restoration and void free restoration due to sonicfill system.

These results were in agreement with Hahnel S. [29] who found that, chemical degradation occurs through prolonged storage times through the formatted pores within the network system through which the oligomers and monomers are lost. So, generally, artificial aging leads to a significant decrease in properties of Flexural Strength.

For depth of cure, the x-traFill composite had the highest mean value, followed by sonicFill resin composite, while the lowest mean value Herculite XRV Ultra resin composite.

This result may be attributed to increase the filler content of x-tra fil resin composite. These results were in agreement with Biradar B. [25] who found that, the factors which affect the amount of water absorption of the composite restoration materials are the resin content, filler content, curing time, distance from composite cured and the coupling agent. The more the filler content of the composite the lesser will be the water absorption.

The present study showed disagreement with (andido et al. [30] who found that regardless of the resin brand, accelerated artificial aging did not influence the microstructure or the mechanical properties.

CONCLUSIONS

1. All studies showed acceptable depth of cure above 80% bottom to top percentage and showed acceptable flexural strength above 80 MPa.
2. X-tra fil resin composite showed better DOC while the sonic fill resin composite showed better FS among the studied materials but the differences was not significant.
3. One month storage time had positive effect on DOC and FS of the studied materials. While three months storage time have detrimental effect on DOC and FS

RECOMMENDATIONS

1. Sonic vibration is recommended with viscous bulk fill materials to decrease internal void formation.
2. Bulk-fill materials could be safely used in deep cavity preparations without compromising the depth of cure.

REFERENCES

1. Abed, Y. A., H. A. Sabry, and N. A. Alrobeigy. Degree of conversion and surface hardness of bulk-fill composite versus incremental-fill composite. Tanta Dental Journal 12.2 (2015): 71-80.
2. Furness, Alan, et al. Effect of bulk/incremental fill on internal gap formation of bulk-fill composites. Journal of dentistry 42.4 (2014): 439-449.
3. Flury S, Hayoz S, Peutzfeldt A, Hüsler J and Luss A: Depth of Cure of Resin Composites: Is the ISO 4049 Method Suitable for Bulk Fill Materials? Dental material journal, 2012; (28), 521–28.
4. Sideridou D and Achilias S. Elution study of unreacted Bis-GMA, TEGDMA, UDMA, and Bis-EMA from light-cured dental resins and resin composites using HPLC. Journal of Biomedical Material Research B Applied Biomaterials, 2005; 74:617–26.
5. Goracci C, Cadenaro M, Fontanive L, Giangrosso G, Juloski J, Vichi A and Ferrari M: Polymerization efficiency and flexural strength of low-stress restorative composites. Dental Material. 2014; 30(6):688-94.
6. Garoushi S, Vallittu P, Shinya A, Lassila L. Influence of increment thickness on light transmission, degree of conversion and micro hardness of bulk fill composites. Odontology. 104.3 (2016):291-7.
7. Ilie N, Bucuta S, Draenert M. Bulk-fill Resin-based Composites: An In Vitro Assessment of Their Mechanical Performance. Operative dentistry, 2013; 38(6):.618-25.
8. Ilie N. High viscosity bulk-fill giomer and ormocer based resin composites: an in-vitro comparison of their mechanical behavior. Stomatology Educational Journal, 2016; 3(1):54-62.
9. Bayraktar Y, Ercan E, Hamidi M, Colak H. One-year clinical evaluation of different types of bulk-fill composites. Journal of Investigation and Clinical Dentistery. 2016; 7(1):1-9.
10. Attar, N., Tam, L.E. and McComb, D. (2003) Flow, Strength, Stiffness and Radiopacity of Flowable Resin Composites. Journal of Canadian Dental Associations, 69, 516-521.
11. Didem, A., Gözde, Y., & Nurhan, Ö. Comparative Mechanical Properties of Bulk-Fill Resins. Open Journal of Composite Materials. 2014; 4:117–121.
12. Ibarra ET, Lien W, Casey J, Dixon SA, Vandewalle KS. Physical properties of a new sonicaly placed composite resin restorative material. General Dentistry, 2015; 63:51-6.
13. Turssi C, Ferrecane j, Vogel K, 2005. Filler feature and their effects on wear and degree of conversion of particulate dental resin composites. Biomaterial. 26(24)pp. 4932-7 .
14. Kim JJ, Moon HJ, Lim BS, Lee YK, Rhee SH, & Yang HC. The effect of nanofiller on the opacity of experimental composites. Journal of Biomedical Materials Research. Part B, Applied Biomaterials, 2007; 80(2): 332-8.
15. Arikawa H, Kanie T, Fujii K, Takahashi H, Ban S. Effect of filler properties in composite resins on light transmittance characteristics and color. Journal of Dental materials, 2007; 26(1):38–44.
16. Guo G, Fan Y, Zhang JF, Hagan JL, Xu X. Novel dental composites reinforced with zirconia-silica ceramic nanofibers. Journal of Dental materials, 2012; 28(4):360–8.
17. Dos santos B, aAlto R, Fiho H, Felowes C. Light transmission on dental resin composites. Dental material: official publication of the academy of dental materials, 2008; 24(5):571-6.

18. Da Saliva M., poskus T. &Guimaraes A. Influence of light-polymerization modes on the degree of conversion and mechanical Properties of resin composites: a comparative analysis between a hybrid and ananofilled composite. Operative dentistry, 2008; 33(3):287-93.

19. Ilie N, Kebler A, Durner J.influence of various irradiation processes on the mechanical properties of low and high viscosity giomer and RBC materials.Journal of dentistry, 2013; 41(8):695-702.

20. Abed A, Sabry H, Alrobegy A. Degree of conversion and surface hardeness of bulk fill composite versus incremental-fill composite. Tanta dental journal, 2015; 12 (2):71-80.

21. Leprince G, Palin W, Hadis M, Devaux J, Leloup G. Progress in dimethacrylateBased dental composite technology and curing efficiency. Dental Material journal, 2013; 29 (2):139–56.

22. Bauer& Ilie. Effects of aging and irradiation time on the properties of a highly translucent resin-based composite. Dental Materials Journal 2013; 32(4): 592–599.

23. Tornavoia D, Satoa S, Silvaa L, Agnellib M, Cândido L. Analysis of Surface Hardness of Artificially Aged Resin Composites. Materials Research, 2012; 15(1): 9-14.

24. Iwami Y, Yamamoto H, Sato W, K. Kawai, M. Torii, and S. Ebisu, “Weight change of various light-cured restorative materials after water immersion,” Operative Dentistry, 1998; 23(3):132–137.

25. Biradar B, Biradar S, and Arvind M. Evaluation of the Effect of Water on Three Different Lights Cured Composite Restorative Materials Stored in Water: An In Vitro Study. International Journal of Dentistry, 2012; 32(1): 1-5.

26. Curtis A, Shortall C, Marquis P, Pali W. Water uptake and strength characteristics of a nanofilled resin-based composite.2008; 36(3):186-93.

27. Medeiros S, Gomes M, Loguercio D, Filho E. Diametral tensile strength and Vickers hardness of a composite after storage in different solutions. Journal of Oral Scientific. 2007; 49(1):61-6.

28. Musanje L, Shu M, Darvell W. Water sorption and mechanical behaviour of Cosmetic direct restorative materials in artificial saliva. Dental Material. 2001; 17(5):394-401.

29. Hahnel S, Henrich A, Bürgers R, Handel G, Rosentritt M. Investigation of Mechanical properties of modern dental composites after artificial aging for one year. Operative Dentistry. 2010; 35(4):412-9.

30. Cândido D, Tornavoi D-%[1] Antônio M, Jardel L, Augusto J, Agnelli M, Microstructure and Mechanical Properties of Composite Resins Subjected to Accelerated Artificial Aging. Brazlian dental journal, 2013; 24,599-604.