

 <p>ISSN NO. 2320-5407</p>	<p>Journal Homepage: -www.journalijar.com</p> <h2>INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)</h2> <p>Article DOI:10.21474/IJAR01/12424 DOI URL: http://dx.doi.org/10.21474/IJAR01/12424</p>	 <p>INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR) ISSN 2320-5407 Journal Homepage: http://www.journalijar.com Article DOI:10.21474/IJAR01/12424</p>
---	---	---

RESEARCH ARTICLE

COMPARATIVE EVALUATION OF EFFECT OF TWO LIGHT CURING UNITS ON MECHANICAL PROPERTIES OF FILTEK BULK FILL COMPOSITE

Dr. Akshay Punjabi¹, Dr. Rahul Rao², Dr. Ashish K. Jain³, Dr. Meenakshi Verma², Dr. Gauri Nayak¹ and Dr. Vishal Naik¹

1. MDS, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai.
2. Professor and P.G Guide, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai.
3. MDS, Head of Department and Professor, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai.

Manuscript Info

Manuscript History

Received: 01 December 2020
Final Accepted: 05 January 2021
Published: February 2021

Key words:-

Bulk-Fill composite, Woodpecker RTA Mini-S, Universal Testing Machine, 3M Elipar Deep Cure L

Abstract

Context: The quality of light curing units can profoundly influence mechanical properties of dental composite materials.

Aim: To compare effect of Woodpecker RTA Mini-S and Elipar Deep Cure-L curing units on mechanical properties (compressive strength, diametral tensile strength and microhardness) of Filtek Bulk-Fill.

Methods and Materials: A total of 32 samples of Filtek Bulk Fill composite were divided into 2 equal groups (n=16). 12 samples in each group were fabricated using a tooth shaped mold and 4 in circular rings to test compressive strength, microhardness and diametral tensile strength, respectively. The blocks were evaluated for the above parameters using Universal Testing Machine and Vickers Microhardness Tester. Independent sample-t test was used in this study (p < 0.05).

Results: The results of this study showed that the group of composites cured using Elipar Deep Cure-L curing unit showed better mechanical properties and the difference between the groups was statistically significant for compressive strength and diametral tensile strength (p < 0.05)

Conclusion: It was concluded that a curing unit of higher intensity and quality of output used in conjunction with bulk fill composites are likely to give better results.

Copy Right, IJAR, 2021,. All rights reserved.

Introduction:-

Light cure composites are one of the most widely used restorative materials in dentistry today. The process of restoration by composites is technique-sensitive and requires adequate light curing to ensure a thorough cure. When restoring cavities using conventional composites, it is recommended to use increments of 2 mm to ensure adequate cure. To overcome these 2 mm increment limitation, increase patient comfort and decrease chairside time, some manufacturers introduced 'bulk-fill' composites. These composites claim to cure adequately upto 4 mm, and thus restorations can be filled with one increment when cavity depth is less than 4 mm. (Brent W Church et al., 2017)

Corresponding Author:- Dr. Akshay Punjabi

Address:- MDS, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai.

The polymerization of light cured materials and their mechanical properties depends on their chemical composition, on the amount of filler particles, as well as on spectral output and irradiance of blue light emitted by light curing units (LCUs). Dentists may choose from a variety of curing sources for the photo-polymerization of composites. (KoraySoygun et al.,2015)

Beginning in the 1970s, several curing units ranging from tungsten quartz halogen lights, plasma arc curing units to lasers were tried and tested. However, due to several advantages Light Emitting Diodes (LEDs) have become the mainstay in dental practice today.(Fahad I Alkhudairy.,2017) To the best of our knowledge, there is no published literature which has tested this combination of curing lights and composite to evaluate the above criteria. Hence this study was undertaken. The null hypothesis tested was that there is no difference in the mechanical properties of composites cured by the two curing units.

Materials and methods:-

Sample size was decided based on previously reported data and was statistically calculated. Depending on the light curing unit used to polymerize the samples, two groups were created (n=18)

Group I: Filtek Bulk Fill cured by Woodpecker RTA Mini S (Co.)

Group II: Filtek Bulk Fill cured by EliparDeepecure-L curing unit (Co.)

Commercially available bulk-fill composite Filtek Bulk Fill (3M ESPE) was used in this study. A plastic, tooth shaped mold with a prepared class I cavity of length 7 mm and depth of 4 mm was used for fabrication of 24 specimen, 14 of which were assigned to each group.

A cylindrical metal ring measuring 4mm in diameter and 3mm in depth was used for fabrication of the cylindrical samples, 4 samples in each of the two groups.

The composite material was packed into the mold, covered with mylar strip coated with glycerine, to prevent formation of oxygen inhibition layer, and light cured for 20 seconds with the tip of the curing units placed in close approximation to the mylar strip. After fabrication of the sample,12 fluted carbide burs (SS White Co.) were used to remove any excess material and finish the composite surface. Bluephase Meter II (IvoclarVivadent USA) was used to measure the intensities of the two curing units.

Compressive and Diametral Tensile Strength Test:

After keeping the samples for 24 hours in distilled water, the samples were tested using a Universal Testing Machine (ACME Engineers, India, Model No. UNITEST -10) at a crosshead speed of 1 mm/min for compressive and diametral tensile strength respectively.Each specimen was positioned vertically (for CS testing) and the circular samples (for DTS testing) were positioned in a specially designed jig and then placed at the base of the testing machine. A stainless-steel rod with a blunt surface was placed on top of the specimen, and a compressive load was applied until failure. Figure 1 describes how the samples were placed in the Universal Testing Machine.

Microhardness Test:

Each of the 12 specimens subjected to VMH testing was fixed in a holder with the test (top) surface perpendicular to the diamond indenter tip of a VMH tester (Reichert Austria Make, Sr.No.363798). Surface microhardness was determined by the application of a load of 50 g for 15 seconds. Utilizing the built-in scale and the manufacturer's conversion table, Vickers values were obtained and converted to microhardness values (Vickers hardness, HV)

Statistical Analysis:

Data expression:

Data for the microhardness, compressive strength, diametral tensile strength (mechanical properties) will be expressed as means with standard deviation (SD) and standard error (SE). 95% confidence intervals will also be presented.

Statistical Analysis

The data microhardness, compressive strength, diametral tensile strength is compared for differences between the two groups (*Deep cure-L* and *Woodpecker RTA Mini S*) using independent sample t-test. All testing shall be done using two-sided tests at alpha 0.05 (95% confidence level). Thus, the criteria for rejecting the null hypothesis would be a 'p' value of >0.05.

Results:-**Compressive Strength & Diametral Tensile Strength:**

Independent sample t-test revealed significant difference among both the groups tested ($p < 0.05$). From the total sample, higher compressive strength ($p = 0.0041$) and diametral tensile strength ($p = 0.0048$) values were obtained for Group II.

Microhardness:

In the prepared samples, two readings were recorded for microhardness, one being at the surface of the sample and the other reading was recorded after the needle penetrated the sample till the bottom of the sample. Higher reading for microhardness was recorded for Group II – samples cured using Deep cure-L light. However, the difference in Microhardness of Group I and Group II was not statistically significant ($p > 0.05$)

Figure 2 is a graph of the 3 physical properties tested using both the curing units.

Table 1 represents the values of the physical properties tested.

Discussion:-

The use of composite resins has rapidly increased during the last couple of decades. Chemical composition, amount of filler particles, spectral output as well as the irradiance of the curing light used affect the polymerization of the resin-based composites. External variables such as temperature, oral media and the mechanical loads acting also have an effect on the restorative materials. (Brent W Church et al., 2017)

The durability and performance of bulk-fill resin-based composites (RBCs) can be evaluated by their mechanical properties. For instance, material hardness is a measure of degree of polymerization and resistance to surface wear. Similarly, resistance to fracture and clinical failure of restorative materials reflect compressive and tensile strengths. Compressive and Diametral tensile strength (DTS) testing are important in vitro analysis that have typically been considered good indicators for simulating the forces that the restorative materials are subjected to under mastication. As it is not possible to measure the tensile strength of brittle materials directly, DTS was adopted by British Standards Institution. Diametral tensile strength testing is a common method for measuring the tensile strength of brittle materials because it avoids some of the difficulties inherent in direct and flexural tensile testing. (K Pradeep et al., 2016). All the properties evaluated in the present study are critical for the clinical survival of resin-based restorations.

Conventional methods of measurement of tensile strength using 'dumbbell'-shaped specimens suffer from difficulties of specimen grip eccentricity and surface stress concentrations that are particularly severe with brittle materials. Other methods of determining tensile strength of brittle materials using specimens of simple shape have been used. One such test is the so-called diametral compression or Brazilian test, was used in this study, in which a disk-shaped specimen is compressed along a diameter. Under the proper loading conditions, tensile stresses are set up at right angles to the loaded diameter, which will result in fracture. The tensile stress at fracture may be calculated from the following simple equation: $S = 2P / rxD T$, where S is fracture tensile stress, P is applied load, D is specimen diameter, and T is specimen thickness. This test has been used extensively to determine the tensile strength of a variety of different brittle materials. (P.D Williams, D.C Smith., 1971)

The depth of cure of a composite is determined by the monomers, the initiators and the shade/opacity of the material. The depth of cure of bulk-fill composites have been investigated using a variety of methods. These include the ISO scraping test, microhardness test, Fourier-transform infrared, and Raman spectroscopy. (Aziz Eltayeb., 2017) Since hardness measurement has been shown to be a practical method to indirectly determine depth of cure for a given resin composite, depth of penetration method was used for testing the microhardness in this study.

During polymerization, the distance between monomer chains is reduced when the weak Van Der Waals forces are converted into covalent bonds. A gradual increase in viscosity of the resin material also occurs during the conversion, resulting in loss of its fluidity (gel-point) and flowing ability (vitrification) After the polymerizing material loses its ability to flow, its elastic properties increase and, consequently, any restraints on the polymerization shrinkage will generate residual shrinkage stresses. (Faria-e-Silva AL., 2017)

Methacrylate composites have an inherent tendency to shrink during polymerization and can shrink to varying degrees depending on the monomers being used. The composite material used in this study, Filtek Bulk Fill contains

two novel methacrylate monomers that, in combination, act to lower polymerization stress.(Aziz Eltayeb., 2017) One monomer, a high molecular weight aromatic dimethacrylate (AUDMA) decreases the number of reactive groups in the resin. The second unique methacrylate represents a class of compounds called addition-fragmentation monomers (AFM). During polymerization, AFM reacts into the developing polymer as with any methacrylate, including the formation of cross-links between adjacent polymer chains. AFM contains a third reactive site that cleaves through a fragmentation process during polymerization. This process provides a mechanism for the relaxation of the developing network and subsequent stress relief.(Filtek Bulk Fill Posterior Restorative Technical Product Profile)

There are many devices that can be used for curing resin-based composite: halogen lights, plasma arc, ultraviolet lights, and light emitting diode LED, however, most recent developments were done for LED because of their several advantages over predecessors: light in weight, no need for cooling fan, decreased exposure duration and long duration of service. Dental professionals want predictability with their products and procedures, sometimes the curing step can feel like a leap of faith. In fact, research shows that 69 percent of bulk fill users are not confident of polymerization deep in the cavity.

Both the curing lights used in this study (Woodpecker RTA Mini S and Elipar Deep Cure Light) were used for the same amount of time, and have the same wavelength of 420-480nm. Both the lights were relatively new, with no time dependent deformation of the intensity. The main difference was in the intensity of the two LED curing lights: Woodpecker RTA Mini S having intensity in the range 1000-1200 W/cm² and Elipar Deep Cure L light having an intensity of 1470 ± 10% mW/cm².(Aravamudhan K, Floyd CJ, Rakowski D, et al.,2006)

The physical properties of the Group – II, the group of composites cured using Elipar Deep Cure L light were significantly higher. Elipar Deep Cure L light, has a homogenous energy distribution and uniform beam profile(Yaman BC et al.,2011), that gives it an edge over the Woodpecker RTA Mini S curing unit. More homogeneous energy distribution means composite restorations are cured more completely throughout the restoration, especially in deep cavities, providing a greater degree of cure and minimizing potential failures. This enables a significantly better depth of cure, even when perfect light positioning is difficult. (3M Elipar Deep Cure LED Curing Lights Technique Product Profile)

In the present study, the depth of penetration by microhardness was higher for Group II at the surface and also at the bottom, however the difference wasn't significant.Regardless of the light curing units (LCU) used; bottom surface hardness values were lower than those of the top surface in both groups.Topcu et al. stated in their study that, bottom surface microhardness levels are lower than top surface microhardness levels in all specimens polymerized with two different light sources.It was found that as the light passes through the body of a composite, its intensity is greatly decreased due to the absorption and dispersion of light by filler particles and resin matrix.(Topcu FT et al., 2010)This decrease results in a gradation of cure; causing a decrease in the hardness level from the top surface to inwards.This fact explains the difference between top surface hardness levels and bottom surface hardness levels in all the materials cured with two light sources.

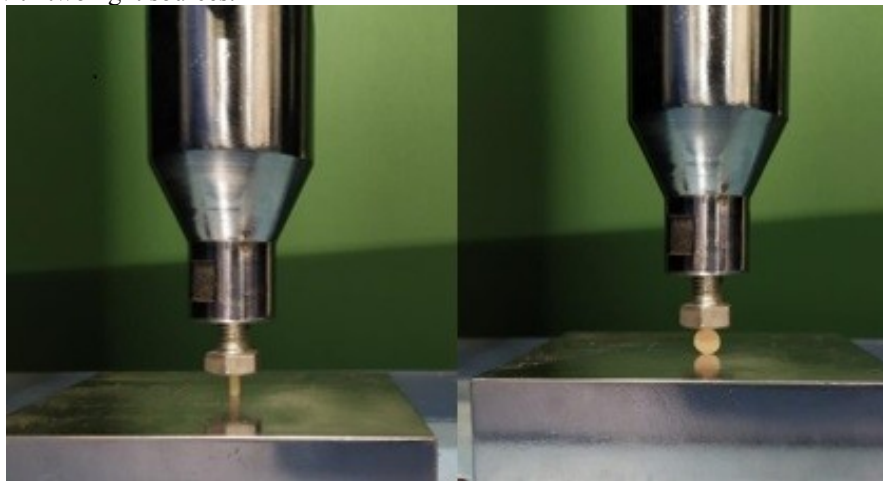
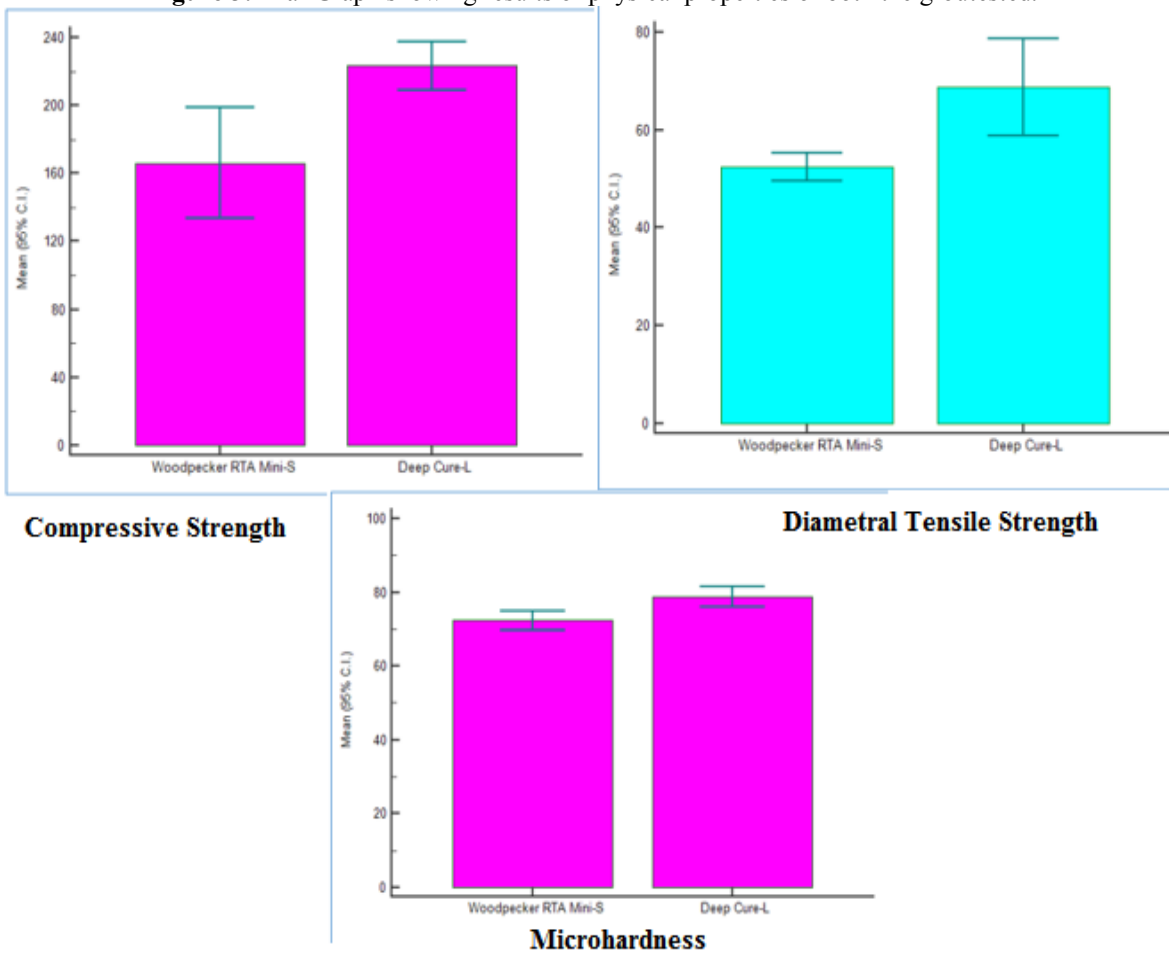


Figure 1:- Rectangular and Cylindrical samples tested under Universal Testing Machine.



Figure 2:- Woodpecker RTA Mini-S (Top)Elipar Deep cure L (Below).

Figure 3:- Bar Graph showing results of physical properties of both the groutested.



Independent samples t-test: Compression strength (MPa)

	Woodpecker RTA Mini-S	Deep Cure-L
Sample size	6	6
Arithmetic mean	166.2262	223.2450
95% CI for the mean	133.5442 to 198.9083	208.7385 to 237.7515
Variance	1528.2149	301.0871
Standard deviation	39.0924	17.3519
Standard error of the mean	13.8212	6.1348

p = 0.0041**Independent samples t-test: Diametral tensile strength**

	Woodpecker RTA Mini-S	Deep Cure-L
Sample size	4	4
Arithmetic mean	52.4150	68.8100
95% CI for the mean	49.5271 to 55.3029	58.8392 to 78.7808
Variance	3.2939	39.2643
Standard deviation	1.8149	6.2661
Standard error of the mean	0.9075	3.1331

p = 0.0048**Independent samples t-test: Microhardness (HV)**

	Woodpecker RTA Mini-S	Deep Cure-L
Sample size	8	8
Arithmetic mean	72.3250	78.8200
95% CI for the mean	69.6225 to 75.0275	76.1615 to 81.4785
Variance	10.4499	10.1117
Standard deviation	3.2326	3.1799
Standard error of the mean	1.1429	1.1243

p = 0.0096**Table 1:-** Table 1 representing the values of the physical properties tested.**Conclusion:-**

Within the limitations of this study, it may be concluded that in general, Filtek Bulk Fill composite displayed better physical properties when used in conjunction with higher intensity curing unit, Elipar Deep Cure L as compared to Woodpecker RTA Mini S. Difference in microhardness at the base of specimen, however, was not statistically significant.

References:-

1. Aravamudhan K, Floyd CJ, Rakowski D, et al. Light-emitting diode curing light irradiance and polymerization of resin-based composite. *J Am Dent Assoc.* 2006;137(2):213–223.
2. Aziz Eltayeb. An in-vitro evaluation of the physical properties of a new bulk-fill composite *J Res Adv Dent* October 2017 5(2) 52-62.
3. Brent W Church, DaraneeTantbirojn, Martha H Wells Depth of cure of Bulk-fill Composites cured in tooth or opaque substrate. *IJEDS* 2017 Dec; 6(2): 68-73.
4. Fahad I Alkhudhairy The effect of curing intensity on mechanical properties of different bulk-fill composite resins. *Clinical, Cosmetic and Investigational Dentistry* 2017;9 Feb; 1-6.
5. Faria-e-Silva AL, Rodrigues MP, Vilela ABF, Pfeifer CS, Tantbirojn D et al. Polymerization shrinkage stress of composite resins and resin cements – What do we need to know? *Braz. Oral Res.* 2017;31(suppl):e62.
6. Filtek Bulk Fill Posterior Restorative Technical Product Profile.

7. K Pradeep, Kishore Ginjupalli, MA Kuttapa, Adarsh Kudva, Roshni Bhutia. In vitro Comparison of Compressive Strength of Bulk-Fill Composites and Nanohybrid Composite World Journal of Dentistry, July-September 2016;7(3):119-122.
8. KoraySoygun, Murat Unal, Ali Ozer, EvremGulnaha and GirayBolayır Effects of Different Curing Unites on Bulk Fill Composites. Int J Oral Dent Health 2015 Aug; 1(3): 1-5.
9. P.D Williams, D.C Smith. Measurement of the Tensile Strength of Dental Restorative Materials by Use of a Diametral Compression T. J DENT RES 1971 50: 436.
10. TOPCU FT, ERDEMİR U, SAHİNKESEN G, YILDIZ E, USLAN I, ACİKEL C EVALUATION OF MICROHARDNESS, SURFACE ROUGHNESS, AND WEAR BEHAVIOR OF DIFFERENT TYPES OF RESIN COMPOSITES POLYMERIZED WITH TWO DIFFERENT TIGHT SOURCES. J BIOMED MATER RES B APPL BIOMATER. 2010 FEB;92(2):470-8.
11. Yaman BC, Efes BG, Dörter C, Gömeç Y, Erdilek D, Büyükgökçesu S. The effects of halogen and light-emitting diode light curing on the depth of cure and surface microhardness of composite resins. *J Conserv Dent*. 2011 Apr;14(2):136-9.
12. 3M Elipar Deep Cure LED Curing Lights Technique Product Profile.