



## RESEARCH ARTICLE

### COMPARATIVE ANALYSIS OF MICROHARDNESS OF TWO BULK-FILL COMPOSITES AT VARYING DEPTHS, PHOTO-ACTIVATED WITH TWO DIFFERENT LIGHT CURING UNITS

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#### ARTICLE INFO

##### Article History:

Received 11<sup>th</sup> May, 2017  
Received in revised form  
02<sup>nd</sup> June, 2017  
Accepted 26<sup>th</sup> July, 2017  
Published online 31<sup>st</sup> August, 2017

##### Key words:

Bulkfill composites,  
Vickers Microhardness,  
Light emitting diode,  
Quartz tungsten halogen.

#### ABSTRACT

**Aim:** The aim of this study is to evaluate and compare the differences of the Micro hardness of two Bulk-fill Composites (Tetric N-ceram Bulkfill and Filtek Bulkfill) and a Conventional composite (Filtek Z350XT) at varying depths (0mm, 2mm, 4mm) and to evaluate the effect of two different light curing systems (LED and QTH) on the micro hardness of bulk-fill and conventional composite.

**Methods and Materials:** 60 specimens of composite resin disks (8x4mm) will be prepared. The Teflon mould will be placed on a glass slab with an intervening mylar strip and the composite resin will be placed at once as a bulk, slightly over packed into the mould space. A second mylar strip and glass slab will be placed on top of the Teflon mould and a uniform weight of 500gms will be placed above the glass slab for 30 seconds in order to compactly pack the resin thus preventing the formation of any voids. Then, the weight along with the glass slab above the composite will be removed and the composite will be cured as per the manufacturer's instructions. All the specimens will stored for 24 hours in distilled water at for completion of the polymerization process.

**Statistical Analysis used:** Mean and Standard Deviation will be used for Descriptive statistics, t test - Independent samples., ANOVA – One way (Analysis of Variance), Scheffe's Post hoc test.

**Results:** Highest micro hardness values regardless of light sources were observed in Tetric N- Ceram bulk fill composite and Light emitting diode showed better hardness values compared to Quartz tungsten halogen unit.

**Conclusion:** Highest micro hardness values regardless of light sources were observed in Tetric N-Ceram bulk fill composite. Filtek Z350XT Conventional composite Showed the least Hardness when placed in Bulk fill technique. Light Emitting diode (LED) showed better results when compared to Quartz tungsten Halogen (QTH) unit.

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**Citation:** Vivek Taduri, 2017. "Comparative analysis of microhardness of two bulk-fill composites at varying depths, photo-activated with two different light curing units", *International Journal of Current Research*, 9, (08), 56458-56461.

## INTRODUCTION

In spite of great advances in resin based composite technologies, an insufficient depth of cure and the possibility of insufficient monomer conversion at depth are the main disadvantages. Since photo-polymerized resin composites were introduced, the degree of conversion was acknowledged as vital to the clinical success of these materials. Photo-cured resin composites polymerize only to a certain depth. This depends on the penetration of visible light through the bulk of the material. It has been shown that the insufficient polymerization may lead to a decrease in the physical/mechanical and biological properties of resin composites (Alrahlah *et al.*, 2014). However, the latest developments in composite technology are materials intended for posterior bulk-filling placement, the so-called bulk-fill

Resin based composites (RBC). The materials can be applied in increments up to 4 mm thickness, thus, skipping the time-consuming layering process. The improved self-leveling ability, decreased polymerization shrinkage stress, reduced cusp deflection in standardized class II cavities, and good bond strengths regardless of the filling technique and the cavity configuration (Nicoletta *et al.*, 2014). Recently LED curing lights preferred over conventional halogen units. Traditional modes use high initial irradiance and provide a higher degree of conversion but a higher shrinkage stress may be induced during polymerization reaction (Poggio *et al.*, 2012). Hence, this study is designed to elucidate the differences in micro hardness of two bulk-fill composites and a conventional composite at varying depths using two different light curing systems.

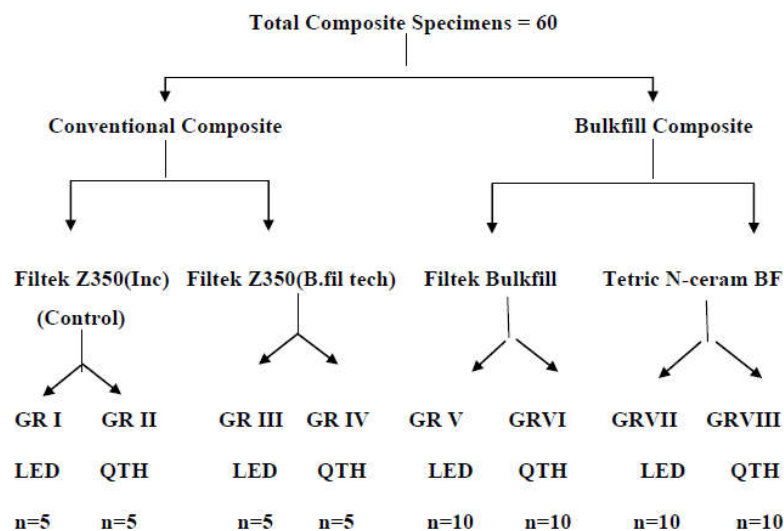
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## MATERIALS AND METHODS

**Table 1. Composition of the composite resins**

Brand	Lot No.	Manufacturer	Type	Composition
Filtek™ Z350 XT	N-726116	3M ESPE	Nanofilled conventional composite	Bis-GMA,UDMA,TEGDMA,PEGDMA,Bis-EMA 20nm nanosilica fillers, 5-20nm agglomerated zirconia/silica particles,0.6-1.4um clusters particle size, 78 wt% AUDMA, UDMA and 1, 12-dodecane-DMA
Filtek Bulkfill	N-718486	3M ESPE	Nanofilled bulkfill packable composite	Fillers are a combination of a non-agglomerated/non-aggregated 20 nm silica filler, a non-agglomerated/ non-aggregated 4 to 11 nm zirconia filler, an aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm zirconia particles) and a ytterbium trifluoride filler.  The inorganic filler loading is about 76.5% by weight (58.4% by volume)
Tetric N-Ceram Bulkfill	R-77064	Ivoclar Vivadent	Nanohybrid bulkfill packable composite	Dimethacrylates (19–21% weight), fillers consist of barium glass, prepolymer, ytterbium trifluoride and mixed oxide Additives, catalysts, stabilizers and pigments are additional contents (< 1.0% weight)

### I. Grouping :



### ii. Specimen Preparation

#### a. Bulk fill Technique

The Teflon mould was placed on a glass slab with an intervening mylar strip and the composite resin will be placed at once as a bulk, slightly over packed into the mould space. A second mylar strip and glass slab was placed on top of the Teflon mould and a uniform weight of 500gms will be placed above the glass slab for 30 seconds in order to compactly pack the resin thus preventing the formation of any voids. Then, the weight along with the glass slab above the composite was removed and the composite was cured as per the manufacturer's instructions. All the specimens were stored for 24 hours in distilled water for completion of the polymerization process.

#### b. Incremental Technique

The Teflon mould was placed on a glass slab with an intervening mylar strip and the composite resin was placed in two increments of 2 mm each using oblique layering technique

and further followed by the steps as described in the bulk fill technique.

#### iii. Sectioning of the specimen

The prepared composite specimen with the dimension of 8mm diameter and 4mm height will be sectioned at the level of 2mm using a diamond disc along with the coolant so as to determine the micro hardness at varying depths.

#### iv. Polishing of the specimen

The Composite specimens were polished with the 1200 grit Silicon carbide paper on top and bottom surface to remove the resin rich layer.

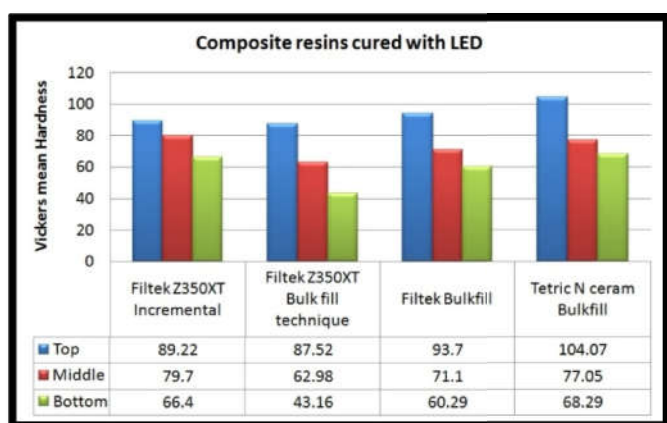
#### v. Evaluation of Vickers Hardness

The micro hardness was measured using the Vickers hardness testing machine. Three indentations were made using a force of 100grams for 10seconds on each surface, i.e. top surface (0 mm), mid surface (2 mm) and bottom surface (4 mm) and the

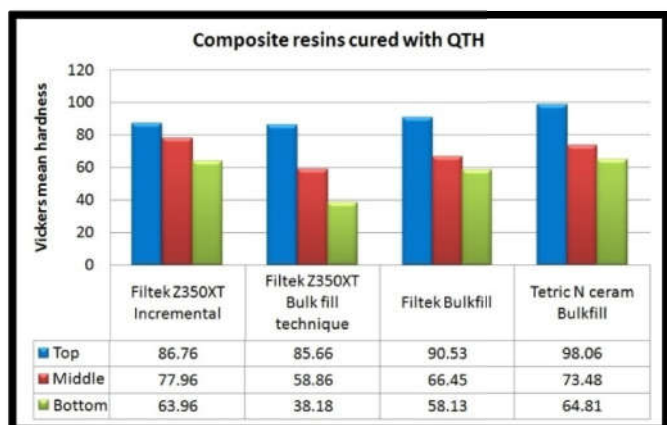
average of three indentations were used for the statistical analysis.

## RESULTS

Highest micro hardness values regardless of light sources were observed in Tetric N- Ceram bulk fill composite and Light emitting diode showed better hardness values compared to Quartz tungsten halogen unit. The Filtek Z350XT conventional composite showed the least hardness values on all the surfaces when placed in bulk fill technique.



Graph 1. Mean Vickers hardness of the composite resins at varying depths cured with Light emitting diode(LED)



Graph 2. Mean Vickers hardness of the composite resins at varying depths cured with Quartz tungsten halogen (QTH)

## DISCUSSION

Resin composites are widely used in restorative dentistry and specifically in posterior restorations, putting the material under constant masticatory stresses. Resin composites with better mechanical properties have been developed over these years. One of the most important parameters deciding the resin composites resistance to stress is the depth of cure. The effectiveness of cure depends on the filler particle type, size, quantity and on the parameters (intensity, time and polymerization modes) of the lightsource (Yap and Soh, 2005). Effective cure of light-activated composites is also important to prevent cytotoxicity of inadequately polymerized material. Bulk- fill composites are new composite materials aimed to decrease the time taken to place the composite in the cavity by reducing the layers that have to be cured. They are also intended to minimize the shrinkage and the resulting stress by

using the same exposure time and light intensity used for the regular composites (Finan *et al.*, 2013). Surface micro-hardness is considered to be important physical properties of resin composites and play a significant role in comparing and characterizing dental restorative materials. Micro-hardness is commonly used for evaluation of the depth of cure and thus, also the efficiency of the curing lights. The possibility of insufficient monomer conversion and the limitations of depth of curing are one of the problems associated with photopolymerized resin composites (Yaman *et al.*, 2011). Evaluating the degree of conversion is considered to be a reliable method however; there is a high correlation between this method and the micro-hardness evaluation (Ihsan Hubbezoglu *et al.*, 2007). There were four basic types of curing lights introduced for the polymerization of light curable restorative materials including, Quartz tungsten halogen curing light (QTH), Plasma arc curing lights (PAC), light emitting diode curing lights (LED) and Argon laser curing units.

The most commonly used lights today in dentistry includes quartz tungsten halogen light and light emitting diode curing units. Hence, the present study is directed towards evaluating the efficiency of the regularly used light sources. LEDs are less energy-consuming compared to QTHs and are more efficient converters of electric power into visible blue light and do not generate high quantity of heat unlike quartz tungsten halogen lights hence do not require external cooling in the majority of products on the market. LED's have a life time of more than 10,000 hours. LED's are resistant to shock and vibration consume less power for operation and has narrow band width (Singh *et al.*, 2011). One of the aims of this study was to compare the effect of LED curing light and QTH curing light on the micro-hardness and the depth of cure of bulk-fill composites. In the present study the curing efficiency of a light emitting diode curing unit- blue phase C8(Ivoclar Vivadent) was compared with a quartz tungsten halogen light –Translux energy (Heraus Kulzer). The efficiency of curing and the micro-hardness of resin composite cannot be evaluated by study the top surface only. The bottom surface micro-hardness is more affected by light intensity and thus the effectiveness of curing<sup>7</sup>. Based on this, micro-hardness of the bottom surface was also measured in this study. Hardness is defined as the resistance of a material to indentation or penetration, and this property is highly related to a material's strength and is used to evaluate the wear resistance and determine to which degree a material will deform under load. Surface hardness is generally accepted as an important property and valuable parameter (Yap, 2000). The results showed that the resin composite type, curing unit, and the bulk thickness are factors that affect the surface micro hardness value of the cured resin composite material. It showed that regardless of the curing unit used, Tetric N-ceram bulk fill resin composite had the highest surface micro hardness results.

Regardless of the light curing units (LCU) used; bottom surface hardness values were lower than those of the top surface in all tested materials. As 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. This decrease results in a gradation of cure; causing a decrease in the hardness level from the top surface to inwards (Khulood Al-Mansour *et al.*, 2015). 4-mm thick composite specimens were used to ensure a uniform polymerization. Since a minimum intensity of 400 mW/cm<sup>2</sup> has been suggested for routine polymerization (Fan *et al.*, 2002). LCUs greater than

this intensity were used with manufacturers 'recommended curing time. In the present study light emitting diode curing light showed a higher hardness value than quartz tungsten halogen light at any given surface. The results can be substantiated based on the difference in the power intensity and wavelength of the lights tested. Light emitting diode curing light used in the present study showed a power intensity of  $1080\text{mW/cm}^2 \pm 10\%$  and quartz tungsten halogen light showed a light intensity of  $820\text{mW/cm}^2$ . The significant difference in the hardness values can be explained by the differences in the curing intensity. The quality of light produced by the dental light curing units directly influenced the polymerization the resin based materials and highly depends on the intensity or strength of irradiation. Second-generation LED curing units, which have a peak activity at 468 nm and perfectly match the absorption peak of camphoroquinone, are ineffective in conjunction with these new initiators. The third generation light emitting diode with Poly-wave technology (3rd generation of curing lights), curing can be performed without restrictions in the wavelength range 380 to 515 nm. The emission spectrum is therefore similar to the effective range of halogen lights (Mohammed *et al.*, 2012). This might be the reason for a better performance Light emitting diode (Blue phase C8). The possible reasons behind the 4mm increments to be cured as a bulk in Tetric N-Ceram bulk-fill Composites could be due to three new patented technologies have been incorporated into a well-proven Nano-hybrid composite formulation: Ivocerin, Stress Relievers and a Light-Sensitivity Filter (Khulood Al-Mansour *et al.*, 2015).

### Conclusion

- Highest micro hardness values regardless of light sources were observed in Tetric N- Ceram bulk fill composite.
- Filtek Z350XT Conventional composite Showed the least Hardness when placed in Bulk fill technique.
- Light Emitting diode (LED) showed better results when compared to Quartz tungsten Halogen (QTH) unit.

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