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Comparative Evaluation of Polymerisation Efficiency of A Composite Using Two Different Light Sources

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I. Introduction

Composite restorations are widely used in conservative dentistry because it is esthetically pleasing, bonds to the tooth, mercury free, requires only minimal invasive procedure, ease of repair, lack of corrosion and cost effective. Dr.RichardPrice 2(013) has described four variables that affect light curing. They are Curing light , Operator technique , Restoration location and Energy required by the resin.These have been characterised as the four 'CORE' variables that affect adequate light-curing .
Aims of light curing a Resin based Composite is achieving uniform and high monomer conversion to full depth of the RBC, the shortest possible exposure time and low shrinkage stress.
Degree of conversion (dc) is the Conversion of monomer chains into polymers .

INFLUENCE OF DC
Ideal DC – 65 %
Increased surface hardness, Flexural strength, Flexural modulus, Fracture toughness, Diametral tensile strength, Wear resistance ,Colour stability, Biocompatible
Reduced DC
Reduced longevity – unreacted monomer dissolves in water, Degradation – hydrolisation of double bonds, Uncured functional groups - plasticizers

FACTORS INFLUENCING DC are Shade,Light curing duration, Increment thickness ,Light unit system used ,Cavity diameter, Cavity location, Light curing tip distance from the curing RBC surface, Substrate through which the light is cured (e.g., curing through ceramic, enamel, or dentin) , Filler type Temperature
The various methods to MeasureDCareHigh performance liquid chromatography, Differential thermogravimetric analysis, Ultraviolet-visible spectrometry and Fourier transformation infrared spectrometry.

AIM
To compare the degree of conversion of a light activated composite resin by two sources of light

Objectives
- To assess the DC of light cure resins using QTH light source by FT-IR
- To assess the DC of light cure resins using LED light source by FT-IR
- To compare the DC between two light sources

Materials
1. Light cure –Nanohybrid Composite[Tetric N ceram (A1 shade) composite Ivoclar]
2. LED(n=5), BLU1200 ,Light intensity of 900 mW/cm^2 , 8 mm diameter light guide tip
3.QTH(n=5), Rolence QTH CU 100 A Light intensity of 600 mW/cm^2 ,8 mm diameter light guide tip

Method
Polytetrafluoroethylenemold 1 mm high 8 mm diameter is prepared. The Molds are placed on a clear glass slab. The Resin composite placed in the moldand covered with a glass slide and Excess removed with a sharp scalpel blade.

The degree of conversion is measured usingFourier transformed infrared spectroscopy (FTIR). The Absorption peaks of aliphatic bonds were assessed before curing. One side of the specimen was exposed to the curing light QTH and LED for 40 seconds.

Later the Specimens were stored in light proof containers for24 hours.TheAbsorption peaks of aliphatic and aromatic bonds were assessed after curing.

DC MEASUREMENT
Remaining concentration of the aliphatic C═C double bonds in a cured sample

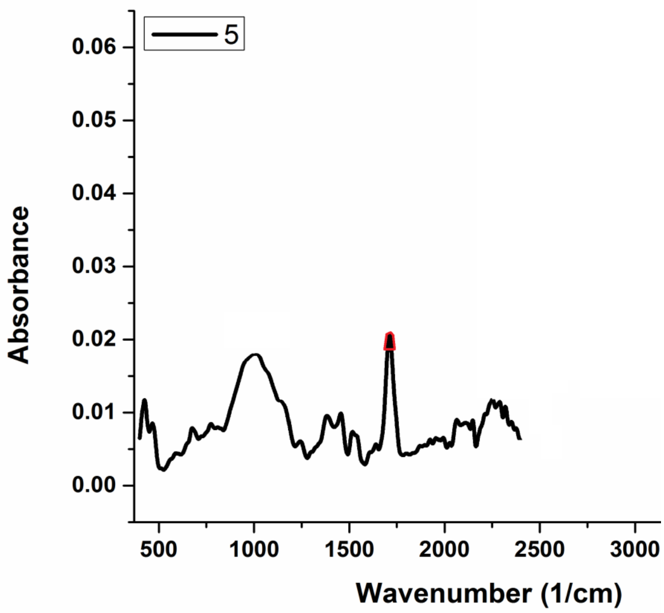
Total number of C═C bonds in the uncured material
DC(%) = 100 × [1 - (R_{cured}/$R_{uncured}$)]
(Arikawa et al.,1998)
Absorbance intensities of aliphatic C═C (peak at 1637 cm^{-1})
Absorbance intensities of aromatic C–C (peak at 1610 cm^{-1})

II. Results

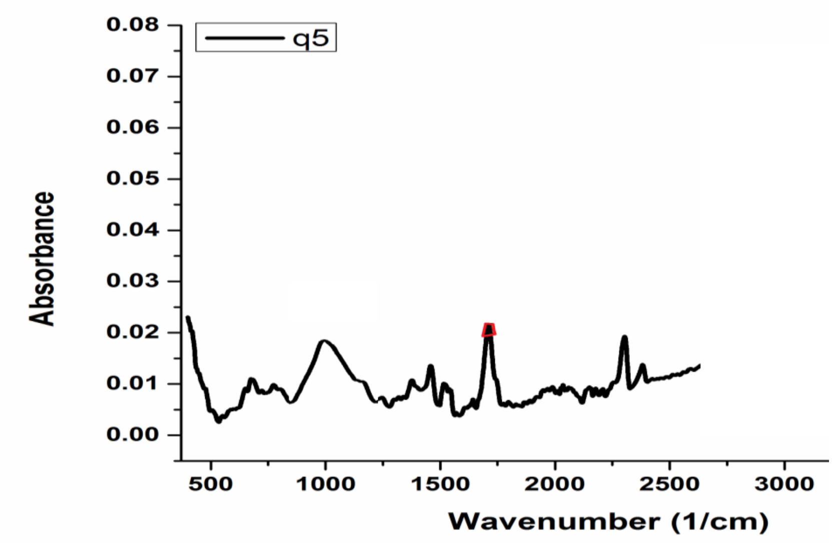
QTHs		***LED***		***UNCURED***	
WAVE LEN	**ABS**	**WAVE LEN**	**ABS**	**WAVE LEN**	**ABS**
CURED AROMATIC		**CURED AROMATIC**		**UNCURED AROMATIC**	
1610.2699	**0.0052323**	**1610.2699**	**0.004141**	**1610.2699**	**0.012321**
1610.2699	**0.005666**	**1610.2699**	**0.004666**	**1610.2699**	**0.01567**
1610.2699	**0.004988**	**1610.2699**	**0.003991**	**1610.2699**	**0.012741**
1610.2699	**0.005115**	**1610.2699**	**0.004333**	**1610.2699**	**0.011876**
1610.2699	**0.005371**	**1610.2699**	**0.004588**	**1610.2699**	**0.013876**
CURED ALIPHATIC		**CURED ALIPHATIC**		**UNCURED ALIPHATIC**	
1637.2684	**0.006161**	**1637.2684**	**0.005461**	**1637.2684**	**0.013654**
1637.2684	**0.005999**	**1637.2684**	**0.005321**	**1637.2684**	**0.012643**
1637.2684	**0.006001**	**1637.2684**	**0.006001**	**1637.2684**	**0.013082**
1637.2684	**0.0067679**	**1637.2684**	**0.005123**	**1637.2684**	**0.013489**
1637.2684	**0.006291**	**1637.2684**	**0.005591**	**1637.2684**	**0.013489**

DEGREE OF CONVERSION			
QTH		**LED**	
Sample-1	**56.205585**	**Sample-1**	**63.19593**
Sample-2	**58.196277**	**Sample-2**	**64.06809**
Sample-3	**57.489303**	**Sample-3**	**61.40187**
Sample-4	**53.378234**	**Sample-4**	**62.76652**
Sample-5	**57.327439**	**Sample-5**	**62.74356**

QTH



LED



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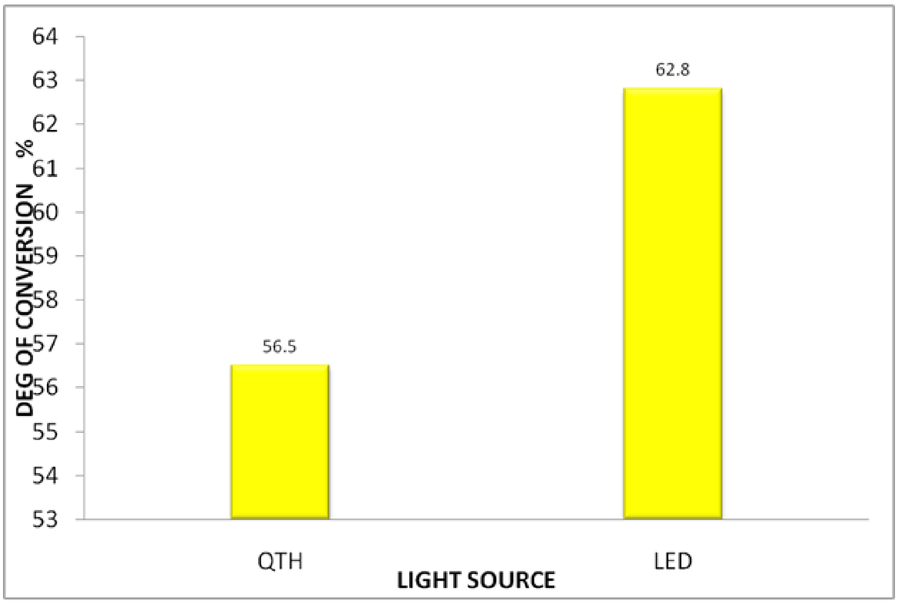

STATISTICS

The samples were tested using the UN-PAIRED T TEST.

	GROUP	N	MEAN	S.D	T -Value	P- Value
	QTH	**5**	**56.519**	**1.695.**	**8.134**	**0.16418.**
	LED	**5**	**62.8351**	**0.8623**		

95% confidence interval
Mean difference = 6.316 (Mean of LED minus mean of QTH)
The 95% confidence interval of the difference: 4.586 to 8.046

III. Discussion

The Curing systems for Light cure used in our study are the QTH and LED.QTH has a Tungsten filament which is heated by electrical energy and has a wavelength of 400 – 500 nm which is broad.LED is a two lead semiconductor in which the Electrons combine with electron holes at the wavelength of 450 – 490 nm which is narrow. Both these curing modes were used to activate the Photosensitive molecules.

According to Nishad et al(2013) LED light curing unit offers better performance for curing nanocomposite resins as compared to QTH light curing unit.

According to R.W.Mills et al (1999) An LED LCU with an irradiance 64% of a halogen LCU achieved a significantly greater depth of cure. Their performance does not significantly reduce with time as do conventional halogen LCUs.

According to Kim M et al LED effectively cured the resin-based composites at one-half the cure time of Halogen while maintaining low Tp.

Clinical Implications is The battery-operated HP LED curing light might be an effective, time-saving alternative for clinicians to use in light curing resin-based composites.

In comparison with QTH, LED curing units have narrower wavelength spectrum (440-490nm) which is sufficient to activate the camphoroquinonephotoinitiator, the diodes have long life span of more than 10,000 hours compared to 40-100 hours life time of (QTH) bulbs. The heat generation is less than the QTH and therefore most of the LED LCUs don't need a fan (Rueggeberg et al., 1996).

In a study comparing the efficiency of different light curing units Price, Fahey & Felix, (2010)82 reported that some curing lights do not provide as muchenergy as recommended and produce softer composites. Rastelli et al. (2014) stated that Halogen LCU showed greater Vickers hardness values than LED LCU mainly because of the power density used.

In another study conducted by Mills, Jandt, & Ashworth, (1999) 58LED LCU with irradiance of 64% of halogen LCU achieved a significantly greater depth of cure. Yaman et al. (2011) found that the LED LCUs were to be more effective than the QTH LCUs regarding both curing depth and micro-hardness properties.

IV. Conclusion

According to the present study DEGREE OF CONVERSION is better with LED.LED is preferred because there is no heat emission, single wavelength and better curing. It improves the overall property and overall longevity of the restoration, but it has to be compared with other light sources.

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