To evaluate the functional efficacy of various light curing units in dental clinics across Chhattisgarh state

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Abstract

Introduction: A clinical survey to evaluate functional efficacy of various light curing units in dental offices across Chhattisgarh state, India.

Aims: The purpose of this study was to evaluate the output intensity & the factors affecting functional efficacy of various light curing units used in private dental office.

Methods and Material: The output intensity of 110 light curing units in various dental clinics across Chhattisgarh state was examined with the help of Bluephase® radiometer. Various factors were also selected and recorded that can affect the functional efficacy of light cure units. The average output intensity was divided into two categories for QTH (<300mW/cm2 & >300mW/cm2) and for LED (<600mW/ cm2 & > 600 mW/cm2).

Results: Among the QTH light cure units, 32 out of 41 (78%) were found out to be satisfactory while 44 LED light cure units out of 69 (63.7%) were satisfactory based on the criteria used for the study (*p*- value= 0.12).

Conclusions: observation found that there is general lack of regular maintenance of these light curing units affects the functional efficacy of these units.

Key words: LED, QTH, Radiometer, Light curing units, Light intensity.

Introduction

The development of light activated composite materials in 1970s proclaimed a time of quick advance in the field of tooth colored restorations. A standout amongst the most popular choices picked by patients in dental practices includes utilizing essentially direct or indirect light-cured tooth-colored resins. In any case, to polymerize a light-cured resin-based composite (RBC) and change it into a hard restorative material that meets the manufacturer's specifications and can withstand the difficulties of the oral cavity, the resin must get adequate light energy at correct wavelengths.(1)

Many variables influence the quality of the energy conveyed to RBC restorations, including: the intensity light yield (irradiance value), the spectral outflow from the light-curing unit (LCU), the wavelength extend required by the photo initiators to be activated inside the resin, the term of light delivery from the LCU to the resin, thickness of the composite increment, shade of the composite and the separation between the curing tip and the resin surface. Of every one of these elements, light intensity accounts to be the most essential.(2)

Controlling these factors will help to deliver an adequate amount of energy (6–36 J/cm2) to the resin, which is important to provide a clinically successful RBC restoration.

Reduced light output can influence the physical properties of the filling: incomplete resin polymerization increases microleakage around resin composite thereby, diminishes the integrity of adhesion, leading to oral fluids and bacterial penetration. The vast majority of the reviews on composite resin- curing stress the significance of adequate output intensity of curing lights.(3) There are four fundamental types of light-curing units (LCU) used by dentists to polymerize light-cured RBCs: quartz-tungsten-halogen (QTH), light-emitting diode (LED), Plasma Arc (PAC), and Argon-Laser units. Clinically, the most mainstream types of LCUs utilized as a part of dental practice are QTH and LED units.(4,5)

The newer era of LED units is conquering the disadvantages of QTH units. These units have a more extended future (10,000 compared with 80 h for a QTH bulb). Nonetheless, such long-term performance should not exempt LED lights from routine in-office assessment. The rate of clinically acceptable LCUs found in various dental practices have differed, from as low as 10% to as high as 70%.

Aim

The aim of this study was to evaluate the functional efficacy of various light curing units in private dental clinics across Chhattisgarh state, India.

Materials and Methods

Materials: The power output from each LCU was measured by means of Bluephase® Radiometer (Ivoclar Vivadent) according to the manufacturer's instructions. It had a detector at the centre and filter placed inside that helps in recording the intensity of the electromagnetic radiation. It digitally displays the intensity of light in mW/cm^2 and it measures intensity of blue light in wavelength range of 385-515 nm.

Methods: 110 light curing units from randomly selected dental clinics in 4 districts of Chhattisgarh state namely, Durg-Bhilai, Raipur, Rajnandgaon and Dhamtari, were evaluated. The procedure was carried out at time that was convenient for the clinician, usually at the end of a clinical session, procedure was explained and written consents were taken prior to examination.

Checking of Irradiance: Inspection of each light curing unit was done. Inspection included examination of the fiber-optic light guide tip for damage (cracks, crazing and chipping) and adherent debris; and assessment of the condition of the electrical lead and outer casing.

Tips were then cleaned to remove such possible contaminants prior to recording the light intensity. The curing tip of each LCU was centered perpendicular to the sensor of radiometer, and the LCU was then activated for a 20-second curing cycle. Three separate readings were made for each LCU, from which an average was obtained and it was considered the final light intensity produced by that particular unit. Apart from the light intensity, other relevant information regarding the light cure unit like the age (years of clinical service of curing unit / aging of bulb) and type of light cure unit, the curing protocol, Frequency of bulb replacement were also documented. The amount of energy density [light intensity (in mW/cm^2) × duration of exposure in seconds needed to cure resin varies in value, from 6 to 36 J/cm^2, and a value of 12 J/cm^2 was set as a minimum energy level for acceptable curing of a 2-mm resin increment. To achieve the minimum energy level necessary for these tested LCUs to be considered clinically acceptable, and depending on the curing time protocol, the QTH unit needed to deliver a minimum irradiance value of 300 mW/cm^2.

This is also supported with ANSI/ADA Specification No. 48-1- Visible Light Curing Units: 2004 which states ''The light radiance existent in the 400 to 515 nm wavelength region should be no less than 300 mW/cm^2''. In contrast, the value was minimally set at 600 mW/cm2 when the LED units were used, since they require less than half the curing time as stipulated for QTH light curing units, as stated by manufacturers of LED light cure units.

So the output intensity were examined under 2 categories:

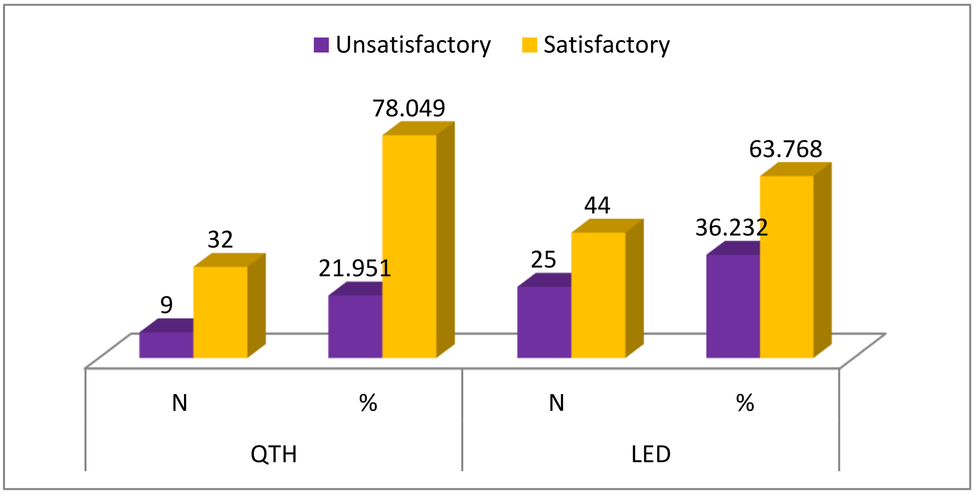
1. QTH - <300 or >300mW/cm2
2. LED - <600 or > 600 mW/cm2

Data Analysis: The results were tabulated and the data was statistically analyzed with the help of ANOVA, and Krussal-Wallis test at 0.05 level of significance.

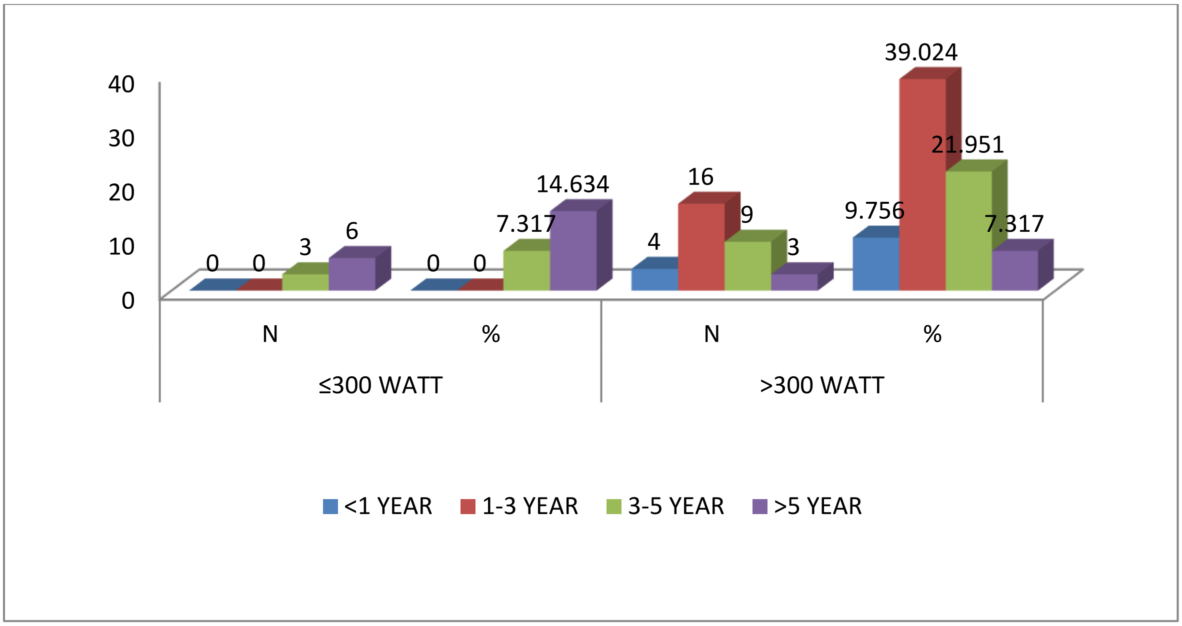
Results

Of the 110 light cure units examined, 41 were QTH (37.3%) while 69 were LED (62.7%). Among the QTH light cure units, 32 out of 41 (78%) were found out to be satisfactory while 44 LED light cure units out of 69 (63.7%) were satisfactory based on the criteria used for the study (*p*- value= 0.12).

Criteria	QTH		LED		
	N	%	N	%	P-Value
Unsatisfactory	**9**	**21.951**	**25**	**36.232**	**0.12**
Satisfactory	**32**	**78.049**	**44**	**63.768**	



Qht/Afe	≤300 Watt		>300 Watt		P-Value
	N	%	N	%	
<1 YEAR	0	0	4	9.756	0.0010 HS
1-3 YEAR	0	0	16	39.024	
3-5 YEAR	3	7.317	9	21.951	
>5 YEAR	6	14.634	3	7.317	



Led/Age	≤600 WATT		>600 WATT		P-Value
	N	%	N	%	
<1 YEAR	2	2.899	23	33.333	0.0010 HS
1-3 YEAR	18	26.087	15	21.739	
3-5 YEAR	5	7.246	6	8.696	
>5 YEAR	0	0	0	0	

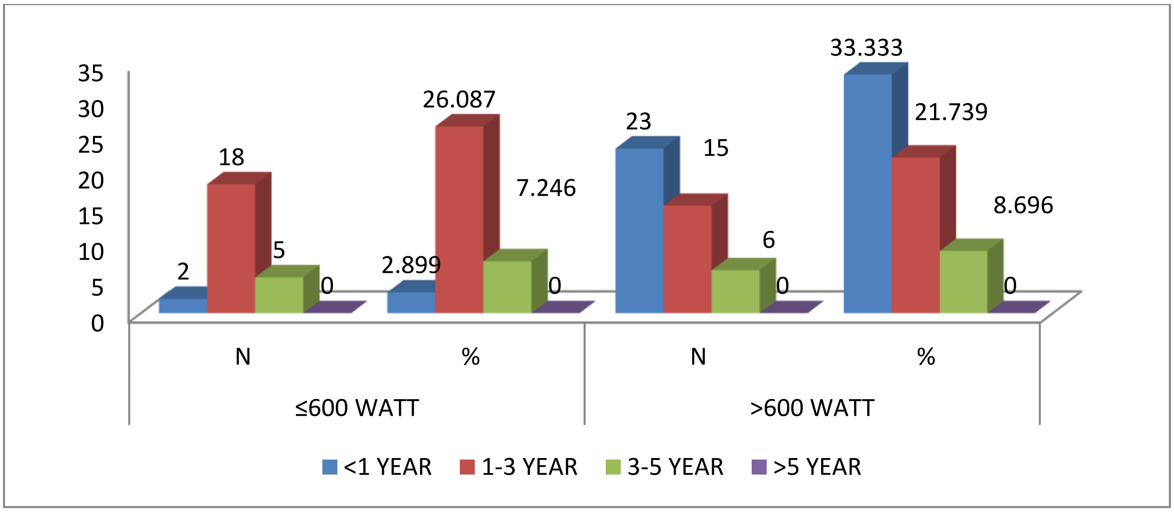
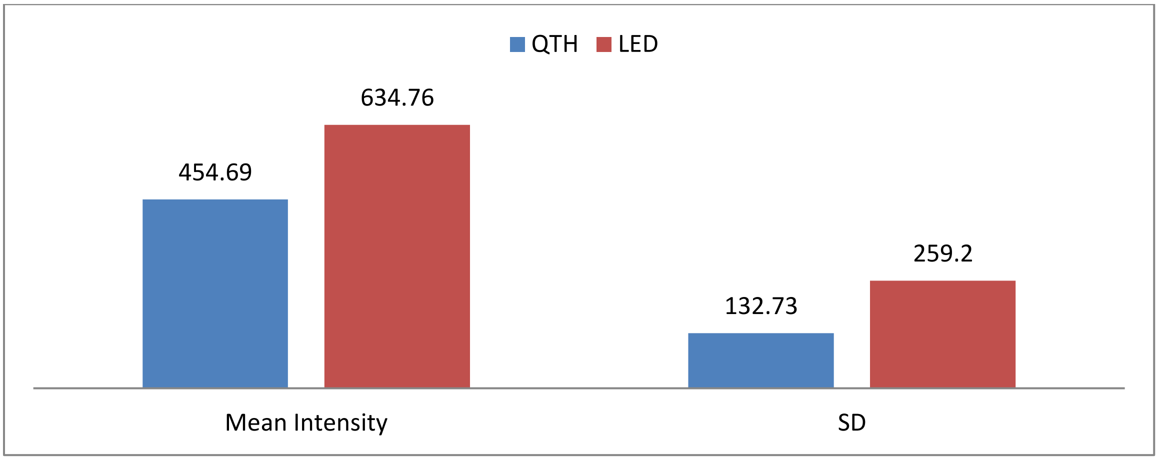


Table 2. Mean intensity

Type	Mean Intensity	SD	95% CI	P Value
QTH	454.69	132.73	414.06-495.32	0.0001 HS
LED	634.76	259.20	573.6-695.92	



Discussion

Light-activated composite materials polymerize by free radical polymerization when presented to light of satisfactory intensity and at wavelengths in the 400 to 500 nm range. Camphoroquinone (CQ) which is a usually utilized photoinitiator absorbs energy and in mix with amine creates free radicals to start the polymerization procedure. Macroscopically, the dental composite hardens, typically after light exposure times going from 20 s to 60 s.[6,7]

Irradiance is an important element to be pointed out because it represents the number of photons delivered to the sample per unit of time, regardless the area illuminated. Inability to accomplish appropriate irradiance results in absence of polymerize adequately, bringing in a low monomer polymer transformation rate which causes: inferior physical properties, more water absorption, microleakage, postoperative sensitivity and staining of the resin composite. Accordingly, both the degree of cure on the surface closest to the light source and depth of cure have been appeared to be influenced by the intensity of the light curing units.3 Nowadays, various sources for photo-initiating composite resins are accessible: halogen lamps, plasma arc lamps, laser and light-emitting diode (LED) lights. The most generally utilized are halogen and LED lamps.[8,9]

This review found that 30-40 % of the units had deficient intensities. 10% of the units in this study recorded levels of light output in the peripheral range (250- 300mW/cm2). In another study conducted by Hegde et al, 51% of light curing units had intensities less than 200mW/cm2.[10] Nearly 70% of the dental professionals studied had never checked the intensity of their light curing units. The present study demonstrated a significant decrease in light intensity with older units. Friedman demonstrated that the lamp degrades gradually with time.[11] Caughman et al detailed that majority of new units initially possessed an satisfactory intensity to polymerize composite resin to a thickness of 2mm.[12]

A relationship was found between substitution of the bulb and sufficiency of light intensity. This is in accordance of investigation of hedge & associates detailed that aging of bulb more than 36months did decrease the light output in curing units.[6] Numerous practitioners inaccurately accept that the halogen bulbs utilized in visible light curing units deliver a steady output until the bulb burns out or fails to produce blue light1. The subsurface layer of a resin based composite increment is influenced most by inferior light intensity. Light curing units ought to in this way be checked routinely to guarantee satisfactory light output. At the point when this reduces, the components, especially the bulb and filter, ought to be checked for deterioration and possible replacement.[13] Numerous authors have exhibited the convenience of the radiometer as a tool for measuring light output from visible light curing units. It has been prescribed that new or repaired units should be tested to ensure adequate light intensity. The units should be monitored periodically, with the initial reading providing a useful baseline for detecting changes in light intensity that occur with ageing.

Conclusions

Within the limitation of this study, survey of the efficiency of light output from visible light curing units revealed that:

1. LED were more prevalent than QTH
2. 78.04% QTH showed satisfactory results as compared to 63.76% LED light cure units which showed satisfactory results
3. There was no association between type of light cure unit and intensity

4. There was an association between age of light cure units and intensity produced by Light cure units.

Proper maintenance of light cure units as well as periodic monitoring of intensity produced by them will pave the way for best clinical results. Further studies can still be performed on the influence of diameter, length of curing tip, different curing units, the rising of temperature at tip and its effect on irradiation intensity and the use of different radiometers for checking the irradiance.

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