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TO DETERMINE THE FUNCTIONAL EFFICACY OF LED UNITS IN VARIOUS CLINICAL OFFICES

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ABSTRACT

Aim: Light units used for polymerization of resin composites are subject to deterioration with age, and frequent maintenance is required to maintain optimal efficacy. The aim of this study was to examine the efficacy of LED units in private dental offices in Baddi (H.P) for polymerization of resin composites.
Materials and Methods: Twenty dental offices met all selection criteria and agreed to participate in the study. To measure light intensity, an analogue radiometer was used. The probe of each LED unit was placed and then measurements of light intensities were recorded for each light unit and the data was statistically analysed.
Results: The light intensity of the individual units varied widely. The results revealed that there was error of 35% and a standard deviation of 155.76 among the intensities of various LED Units checked in the study.
Conclusions: Light polymerization units in private dental offices displayed a wide range in light intensity, and many had below-recommended levels. A positive linear relationship was found between light intensity and photoactivation effectiveness. Dentists should regularly monitor the condition of light units and replace deteriorating parts.

Key words: Composite, LED, Wavelength, Polymerisation.

INTRODUCTION

The use of resin composites for restoration of Class I and II preparations has increased significantly in recent years because of environmental concerns about mercury in amalgam, increasing patient demand for more esthetically pleasing restorations, and the development and marketing of new resin composites. Although resin composites are available in both auto-polymerized and light-polymerized forms, dentists prefer the light-polymerized composites because of better handling characteristics. Most light-polymerized composites contain a light-sensitive absorber such as Camphoroquinone, which initiates polymerization by breaking down into free radicals when subjected to light in the blue spectrum (wavelength 450–470 nm).[1]

Energy densities (J/cm^2 or mWs/cm^2), i.e. the product of light intensity (mW/cm^2) and irradiation time(s), have been suggested to account for variations in irradiation intensity, time and mode. The same degree of conversion is produced by a fixed amount of energy (energy density: J/cm^2), independent of variations in light irradiance.[2] Four types of polymerization sources have been developed and applied: quartz tungsten halogen (QTH) lamps, light emitting diodes (LED) units, plasma-arc lamps and argon-ion lasers. LED units are overwhelmingly applied in daily clinical practice. Although the most common method of photopolymerization uses QTH curing units, these units have important disadvantages. The incandescent filament produces heat, which is harmful to pulp integrity. Although fans are used with QTH units to reduce the temperature increase, this makes the units heavier and less energy-efficient. In addition, halogen lamps produce a wide spectrum of light, so optical filters are necessary.[3] However,

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the bulb, reflector and filter of halogen LCUs degrade over time due to the operating temperatures and the large quantity of heat generated, resulting in a reduction of the curing effectiveness of halogen LCUs over time[4] (Figure 1).

LEDs use a combination of two different doped semiconductors instead of a hot filament. The spectral output of gallium nitride blue LED conveniently falls within the absorption spectrum of Camphoroquinone. Therefore, they do not require filters to produce blue light and they convert electricity into light more efficiently. They produce less heat so no cooling fan is required and they can be smaller and cordless. Moreover, LEDs can operate for thousands of hours with a constant light output in power and spectra.[5]

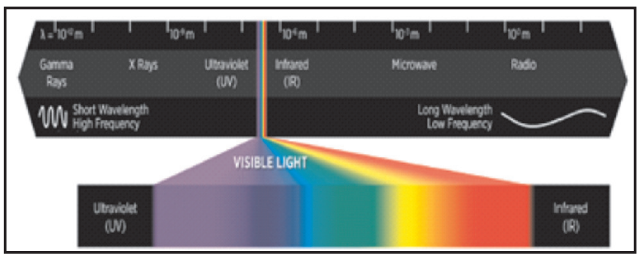

Figure 1: Electromagnetic spectrum illustrating Visible Light Spectrum

An adequate polymerization of resin composites is essential for the ultimate success of the restorations. The degree of cure of resin composite materials influences their mechanical properties, solubility, dimensional stability, color change and biocompatibility.[6] According to Rueggeberg[7], light sources with intensity values less than 233 mW/cm^2 should not be used because of their "poor cure characteristics." Light units with intensities of less than 200 mW/cm^2 or less than 300 mW/cm^2 as inadequate, unusable or unsuitable.[1] The proper characterization of LEDs became of central importance for many LED manufacturers and users. At present many manufacturers produce LEDs of different light colour and mechanical structure. Without a unified characterization of the LED products the user is unable to select the unit which would suit his application best.[8] In addition to the correct wavelength, sufficient light intensity and exposure time are also important for optimal polymerization.[5] Therefore the aim of this study was to check the functional efficacy of LED units in various clinical offices .

MATERIALS AND METHODS

The following selection criteria were used to identify various dental offices for participation in this study.

- The dentist operating the office had to be a general practitioner or a specialist.
- The dental office had to be accessible by public transportation.
- The light polymerization unit(s) in the offices should be LED Cordless Units.
- The dentist had to routinely use resin composites for restoration of posterior teeth.

For each office that met selection criteria, the dentist was contacted by telephone, at which time the study was explained, the dentist's interest was determined, and the methods were briefly explained. This process was repeated until 20 dental offices meeting the previously stated criteria had agreed to participate. Altogether, 40 offices were initially contacted. Once agreement to participate was reached, an appointment was made for a visit to the office at a mutually convenient time. Upon arrival at each office, the purpose and methods of the study were explained to them in detail. The number of LED light units in the office and information about each unit, including approximate date of purchase and service history, as provided by office personnel or dentist, were recorded.

To measure light intensity, an analogue radiometer (BLUE LUXAR), with a range from 0 to 1,000mW/cm^2, was used (Figure 2). According to the manufacturer this meter detects light in the wavelength range of 400 to 500 nm. Each day before visiting the dental office, the light radiometers were examined against another light radiometer to ensure consistency of readings. At each office, the probe of each LED was cleaned before placing on intensitometer. The probe of each LED unit was placed and then measurement of light intensity were recorded for each light unit.[1] One of the LED Unit among twenty Clinics was not working at that time, so the readings were taken for nineteen LED Units. To conceal the identity of Clinics, they are denoted by the number. The data was collected (Table 1) and statistically analysed.

One of the LED Unit among twenty Clinics was not working at that time, so the statistical analysis

Figure 2: Intensitometer taking reading of LED unit

was done for nineteen values. The results (Table 2) revealed that there was error of 35% in the intensities of various LED Units. It also depicted that there is a standard deviation of 155.76 among the intensities of various LED Units included in the study.

RESULTS

Table 1: Depicting the readings of intensities of LED Units of various clinics

Names Of Clinics	Readings of Intensities
First dental clinic	480
Second dental clinic	174
Third dental clinic	390
Fourth dental clinic	508
Fifth dental clinic	1128
Sixth dental clinic	560
Seventh dental clinic	490
Eighth dental clinic	520
Eleventh dental clinic	434
Twelfth dental clinic	680
Thirteenth dental clinic	460
Fouteenth dental clinic	440
Fifteenth dental clinic	530
Seventeenth dental clinic	520
Eighteenth dental clinic	500
Nineteenth dental clinic	560
Twentieth dental clinic	780

Table 2: Depicting the Statistical Analysis of the study

SAMPLE STATISTICS T- Test				
	N	Mean	Std. Deviation	Std. Error Mean
VALUES	19	553.00	155.761	**35.734**

DISCUSSION

Postoperative sensitivity may occur because of partial dissolution of unpolymerized material at the tooth–restoration interface, and recurrent caries along the interface may occur. Inferior mechanical properties of the restoration may result in excessive wear or possibly bulk fracture of the composite.[9-12] In spite of previously published reports about the intensity of light emitted from polymerization units used in private dental offices,[9-12] the present study indicated continued wide variation in light intensity in dental offices including some offices with units emitting light below minimum operational levels. As light intensity is directly associated with the polymerization of resin composites[10], low-intensity values are of concern. Inadequate light polymerization of resin composite restorations might cause a number of clinical problems.[11]

Optical safety for LEDs, lamps and other light sources refers to the prevention of potential hazards caused by optical radiation (electromagnetic radiation of wavelengths ranging from 100 nm to 1 mm).[13] Effects on the eyes as well as the skin are considered, including people with a higher sensitivity to light exposure. The light output from all units is different in several respects. Not all wavelengths of the emitted light are useful for the composite's curing process. Cook[14] found the light between 410 nm–500 nm was the most effective. Between 410 nm–500 nm the LED has 40% of the power output. Due to the smaller light guide tip, however, the irradiance produced by the LED is 70%. Ninety-five per cent of the total flux for the LED lies between 410 nm–500 nm. The flux from the LED peaks at 460 nm and is concentrated over a much narrower wavelength band. Depth of cure is a significant first step as this depends on the quantity of useful blue light energy that can be applied to a given volume of composite in a reasonable time. Blue light in different parts of the absorption spectrum of Camphorquinone has a different effectiveness, and that light near to the absorption peak is more effective at curing.[15]

The high intensity LEDs plays an important role in therapeutic application, aggregating the technology of solid-state devices and a variety of electronic converters that supplying these long-lifetime devices for controlling the output current, output power, duty cycle and other parameters that directly interfere in luminous efficiency in the wavelength and the response of treatments applied to human health.[16] The penetration of light in human tissue is linked to the wavelength, that is, greater the length greater will be their interaction in human tissues as shown in the Figure 3, since these wavelengths respect the range of visible light. Therefore, the application of a particular wavelength directly connected with the color should be used cautiously.[15]

It is important to emphasize that the performance of the light sources can be decreased by the inadequate maintenance of the optic fiber and light transmitter tip. It is important to consider that the inadequate conservation of the light sources is related to a smaller intensity of light emission. This premise was corroborated by the results obtained by this present study. It can be affirmed that the conservation state of the light sources was directly related to the power density observed. The adequate photopolymerization of a resin composite is linked to the light intensity and to the exposure time.LED sources required a minimum light intensity of 300 mW/cm² and at least 20 seconds of exposure time.[15]

This present study observed that 35% of the light sources did not exhibit proper wavelength. The literature has described that this clinical situation can result in aesthetic involvement, marginal microleakage, and decrease of the physical and biological properties of the resin composites. Based on the forementioned discussion, it can be affirmed that the conservation state of the light source directly interfered in the photoactivation effectiveness. It is necessary to have the periodical maintenance of the light sources, as their conservation state is related to the power intensity and consequently with the polymerization effectiveness. Therefore, the clinic staff must be aware of these requirements regarding the use of the light sources and the need of a preventive maintenance protocol to achieve the photopolymerization effectiveness.[17]

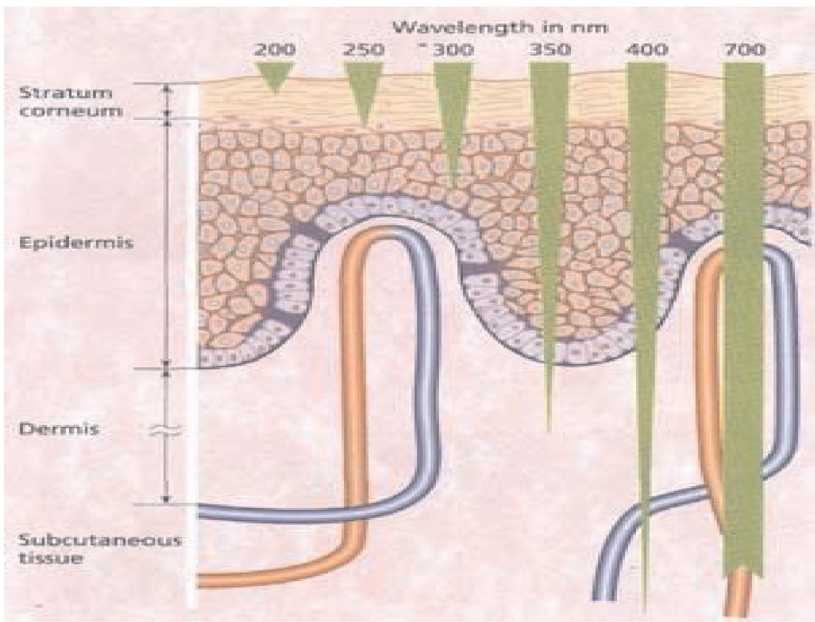

Figure 3: Action of color and penetration depth in human tissue.

CONCLUSION

The clinical effectiveness of the light sources was dependent on their conservation state and power density, which were inadequate for most of the sources tested.

The light sources in clinical use exhibited similar conditions of conservation state and power density, regardless the clinic where they were located.[17]

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