Review Article

Light Cure Devices

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Abstract

With the invention of light-cured resin materials used in bonding and restorations, the use of light cure units has become an integral part of dentistry. There is a vast change in the curing devices over the last 30 years. At present, the following types of light-curing devices are available – Quartz-tungsten-halogen, light-emitting diode, plasma arc curing, and Argon laser. This review is primarily focused on discussing the types and limitation of each type of light cure units and also maintenance of light cure units to optimize their use.

Keywords: Curing units, eye protection, light emitting diode, Quartz-tungsten halogen unit

Introduction

In this era of esthetic dentistry light-activated resin cement, bonded direct, and indirect restorations have become the material of choice and light cure units an integral part of the procedure. The materials which require photopolymerization include pit and fissure sealants, direct and indirect resin composite restorations, resin-modified glass ionomer, etc.[1] At present, 4 types of curing lights are available; conventional Quartz-tungsten halogen (QTH) unit, light-emitting diodes (LEDs), plasma arc curing (PAC), and argon laser curing. The success of restoration depends on the effectiveness of curing as inadequate polymerization may lead to tooth sensitivity, microleakage of components of restoration, fractures, or complete debonding of restorations.

Quartz-Tungsten-Halogen Lamp

Dentists have been using QTH polymerization unit to polymerize composite resin for nearly 30 years.[2] Conventionally, a QTH source, filtered to provide blue light has wavelengths starting around 380–400 nm and ending around 500-51 nm.[3] Since they have such a wide spectrum they are capable of curing short wavelength photoinitiators as well as camphorquinone (CQ).[3] The standard intensity of the QTH sources has been approximately found to be 600 mW/cm^2.[4] This intensity can adequately cure most dental composites to a depth of 2 mm in approximately 40 s.[5] They produce light by passing a current through a tungsten filament housed in a quartz bulb filled with halogen gas. As the current passes through the filament, most of the energy generated is changed into heat, but a small portion is given off as light, and a filter allows only blue light to pass.[6] This explains excessive heat generation by QTH units which in turn leads to damage of bulb components and decreases lifespan of the curing unit to 100 h.[7-10] Another drawback of QTH-curing units is that only a small portion of the halogen emission spectrum actually is used to active the photoinitiator molecules when the CQ absorption spectrum is compared with emission characteristics of halogen lights.[6]

Argon Laser-Curing Units

A lot of research has been done on the use of argon laser for photopolymerization of composite resin restorative materials since 1980 and this interest has arisen because the wavelength (488 nm) of light emitted by the argon laser is optimal for the initiation of polymerization of composite resins[11,12] The argon laser units do not employ the use of filters unlike QTH-curing units but instead, it generates one wavelength of blue light (monochromatic light) having a bandwidth of only 400–450 nm[12,13] Advantages of argon laser include reduced curing time, improved depth of cure, and reduced heat generation but the most important one being that argon laser radiation alters the surface chemistry of both enamel and surface dentin reducing the risk of recurrent

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carries[14-18] They are especially useful in class 2 restoration as it provides easy access to the interproximal box because of the small fiber size but in case of large restoration it becomes a drawback.[1] The drawbacks include bulkiness, heat generation, and nonaffordability[19] also there is a 30-s time lag between turning the unit on and actual light emission.[20] The dentist must determine the risk to surrounding tissues when laser is used since when laser light hits the target, it may be absorbed, transmitted, scattered, or reflected.[21]

Plasma Arc Curing Lamps

To save irradiation time as an economic factor PAC lamps emitting visible light at higher intensities were introduced.[22] PAC-curing lamps polymerize composite in the least amount of time by producing a power density of 100 mw/cm^2.[23] PAC lamps apply a high-voltage current across two closely placed electrodes, resulting in a light arc between the electrodes[24,25] PAC-curing lamps have a 5 mm spot size and a bandwidth of 380–500 nm.[1] The manufacturers of this lamp, due to its tremendous energy output claim that 3 s irradiation with PAC lamp gave same material properties as with 40 s curing with QTH lamp.[26] However, of late this claim has been proved wrong[26-30] The drawbacks include that the source requires a wait time (minimum 10 s) after each use to allow the unit to recover since it gives tremendously powerful light energy.[31] In a study done by Hoffman hybrid composite cured by PAC produced inferior mechanical properties as it contains CQ and other short wavelength absorbing photoinitiators (370–450 nm), thus giving a conclusion that the suitability of plasma unit depends on the photoinitiators the resin composite contains.[32] The efficiency of PAC lights for curing in deep preparations or thick composite layers has been questioned.[8] According to the results from a study by Cavalcante, there is significant gap formation when PAC units are used which is more than that in argon laser but lesser than QTH units, also hardness is comparatively less especially in the bottom region.[33]

LED-Curing Units

To overcome the disadvantage of halogen polymerization light, in 1995, Mills *et al*. proposed using solid-state LED technology.[34] Several generations of LED light-curing units have been introduced over the last few years:[35] 1st-generation LED lights generally were low in intensity and did not cure materials completely as the diodes were designed to activate only CQ, 2nd-generation LED light-curing units have a single, high-powered diode with multiple emission areas, and these units have a large surface area of emission and high-energy output; and 3rd-generation LED light-curing units have two or more diode frequencies and emit light in different ranges to activate CQ and alternative photoinitiators. When subjected to an electric current, electrons, and holes recombine at the LEDs p-n junction of a semiconductors material such as gallium nitride, leading to the emission of blue light.[36] The emission spectrum falls between 450 and 500 nm.[3] They are battery operated, portable with little heat emission.[35] LED units do not require fillers as they have a narrow band that falls in absorption spectrum of CQ[34,37] According to a study conducted by Mousavinasab, the hardness values and depth of cure obtained by LED units was greater than with the QTH light and also the thermal changes on using QTH light for 3 s were same as using LED light for 40 s.[38] LEDs are resistant to shock and vibration, consume little power on operation and have a shelf life of 10,000 h.[1]

Maintanance

Checking of a number of features of the light cure unit is necessary to ensure that it works to the optimum. Resin contamination on the curing tip tends to scatter the light, thus reducing the effective output.[39] Hence, the tip requires to be cleaned using an appropriate rubber wheel and slow handpiece. According to the study by Friedman, the polymerization units used in dental practices have lost 45%–89% of their initial intensity due to lack of maintenance.[40]

Occular Hazards and Eye Protection

The blue light emitted from various light-curing devices is reportedly harmful for human vision.[41] It has been demonstrated that the blue light in the process of producing free radicals in composite to cure also produces free radicals in the eye.[42] These free radicals react with the water content of the cells to produce peroxides which are highly reactive and denaturate the delicate photoreceptors called retinitis.[43] Hence, effective eye protection against blue light is mandatory. Best method would be to avoid looking at the blue light completely or to cover the curing area with reflective side of mouth mirror.[1] A number of colored plastic glasses and hand-held shields are also available.[44]

Conclusion

Appropriately polymerized material shows good physical and mechanical properties in turn promote success of restoration. Thus, an ideal light cure unit having maximum diameter of curing, minimal heat generation, ease of use, durability, portability, and cost-effectiveness should be used. Periodical evaluation and maintenance of the curing unit should be done for optimal use.

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Conflicts of interest

There are no conflicts of interest.

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