**REVIEW ARTICLE**

**Use of Different Light-Curing Units in Setting of Dental Restorative Materials**

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**ABSTRACT**

The resin based filling materials were introduced in dentistry at the end of the 1940s. Poor color stability, low stiffness, lack of adhesion to tooth structure were the major drawback of this class of restorative material. Polymerization shrinkage is one of the challenges which needs improvement of this material to many methods were developed. Light curing units which were the major breakthrough and the energy efficiency of the different light sources have also been discussed.

**KEYWORDS:** Dental light curing units, Light emitting diodes, Resin composites, UV light, Quartz Tungsten Halogen light units.

**INTRODUCTION**

The restorative materials have been used in dentistry for a very long time. One of the first aesthetic restorative material introduced in 1873 by Thomas Fletcher was silicate cement¹. This cement did not become popular until the early 1900s. The main advantage of silicate cements as it superior aesthetic properties and the release of fluoride, however, it was only partly soluble in the oral cavity². Resin-based materials were introduced in dentistry at the end of the 1940s. Besides with their popularity, the disadvantages were also associated with this class of direct restorative materials, such as, polymerization shrinkage up to 20 - 25%, poor color stability, low stiffness and lack of adhesion to the tooth structure³.

The activation of resin restorative materials, several types and designs of light activation unit are available for initiating the polymerization of light-activated materials. The conventional type of blue visible light activation unit was introduced around 1970s. It is based on light produced by quartz tungsten halogen bulb (QTH)⁴. For the early dental resin composites, polymerization was initiated by mixing of the two pastes of different component, in which one paste contained an activator, such as a tertiary amine. This was used to split the initiator, usually benzoyl peroxide, which was found in the second paste. The UV light, with a wavelength of approximately 365 nm, splits benzoin methyl ether into free radicals, without the incorporation of tertiary amines, thus responsible for the polymerization of composite resin⁵. In this way, only one paste of composite was necessary and polymerization did not start until it was activated by the UV light. Along with the advantages of UV light, there were some serious drawbacks associated with the UV light-curing systems. The spectral distribution of UV light it may cause damage to the eye and may burns soft tissue. The depth of cure was limited because of high light absorption in the dental resin composite⁶.

Glass-Poly (alkenoate) dental cements, commonly known as glass ionomer cements (GICs) are set by an acid-base reaction between polymeric acid typically a polyacrylic acid (PAA), and an acid degradable glass known as “Bioactive glass”. It is a generic term for a group of silicate glasses which have a highly disrupted structure (consisting of SiO₂ silica chains with a large number of non-bridging oxygens – two per silicontetrahedron)⁷. Control over the reaction rate is often achieved by the addition of tartaric acid⁷. In more recent developed resin-modified glass-ionomer cements there is also a light catalyzed free radical polymerization reaction of a hydrophilic methacrylate-based monomer⁸,⁹.

**Literature Review**

Different types of light curing units are used in
dentistry. It can be divided according to the light source and/or curing mode used. The first light source used for the polymerization was **UV light**, which was produced from a mercury discharge lamp.

**Quartz Tungsten Halogen light units (QTH).** In this curing unit the bulb is filled with the mixture of gases like halogen, iodine or bromine. It also contains a tungsten filament which glows and produces a very powerful white light when it is attached to an electrical source, which is filtered to the range of blue light (400-500 nm). The major demerits are the production of heat, short life of the bulb, deterioration of the reflector and a filter, over the period of time. The recommended density of QTH was 300-400 mW/cm² which were adequately enough to cure a 2 mm incement of dental resin composite during a 40 second light cure.

High intensity light-curing unit was introduced in 1990s in which the light is generated by high voltage between two tungsten electrodes, separated by a small gap. This produced the gaseous environment (Xenon) and created a conductive gas known as plasma, as **plasma arc (PAC)** light unit. The curing unit was responsible to produce densities more than 2000 mW/cm² and was marketed with recommended curing times of 3 seconds per increment of resin composite. Only 2 or 3 seconds of exposure is required with plasma arc lamps to achieve the same depth of cure obtained with a 30 second exposure to a typical QTH lamp. The **Argon Laser** is recommended as a device for the curing of composite resin at 2-mm depth for five second argon laser exposure. There are two potential advantages of the laser light, firstly that the radiation is produced in a narrow wavelength distribution and secondly that the lasers are capable of emitting a collimated beam of radiation which may travel a large distance without dispersing. This device is costly.

**Light emitting diodes unit (LED)** was introduce in the late 1990s. LED has a narrower wavelength spectrum and requires no filters as compared to the quartz tungsten halogen light units. It has therefore; many advantages over the QTH, as it produces less heat and more appropriate power densities to cure the resin composites. This is more energy efficient and the power densities are now available up to 900mW/cm². The advancement of a design in a device play an important role to facilitate the cross infection control; It may also reduce the thermal changes because it emits no heat during use. They have a limited and specific spectrum of light output, which is responsible for the activation of initiators in a resin composite curing.

**Factors affecting the degree of cure**
The irradiance of the curing unit, the exposure time, the resin shade, the filler size, the filler load and the distance between the light-tip and the resin composite, all affect the extent of cure. As light passes through the bulk of the restoration, its intensity decreases greatly, thus decreasing the curing efficacy and limiting the depth of cure. Inadequate cure hampers physical and biological properties of the resin composite restoration. In certain clinical situations there is unavoidable a distance between the light-tip and the surface of the composite. It has been shown that the mean distance of the light-tip to the gingival floor of a Class II molar cavity is 6.3 mm.

**DISCUSSION**
Most of the dentists preferred visible-light activated resins adhesive for decades. However due to new development in recent years the resin cements are utilized in luting cast ceramics, full porcelain, and veneer restorations that are thin or translucent to permit visible light penetration and thus polymerize the cement. Light-activated cements may be radiolucent and are usually provided in various shades since they are utilized in esthetically demanding situations.

Quartz-tungsten-halogen lights (QTH) are the most frequently used curing units to photoactivate resin-based dental materials. Since the introduction of LED, studies have been made on the influence of these lights on the mechanical properties of resin-based restorative materials. However, few studies are known in literature regarding the influence of LED lights on the mechanical properties of resin-modified glass ionomer cements (RMGIC) and compace.

Conventional halogen bulbs, argon laser and xenon arc lights are currently used in clinical practice. A new technological approach for curing light activated oral biomaterials has been presented. The new light curing unit (LCU) is based on blue light-emitting diode (LED). The main potential benefits of LED LCU technology such as, long lifetime of LED LCU (several
thousand hours), lack of filters or cooling fan no decrease of light output over lifetime with resulting consistent and high quality of material curing is required. Simple depth of cure experiments of dental composites cured with LED technology show promising results. The comparison of energy efficiency among different light sources depends on the relation between power input and light output. For QTH the energy efficiency is 0.7%, for PAC 0.2%, for Laser 0.02% and for LED 13%34. The reaction acceleration, deceleration, and maximum rate were dependent upon the irradiance of the curing light source35. Because of this high energy efficiency of the LED and the absence of a fan, the LED units are not as energy consuming as QTH units. The microhardness values, when a LED light was used, varied depending on the restorative material tested36.

CONCLUSION
The latest generations of LED curing units were able to cure resin composites to a higher degree of conversion than the control QTH unit.

REFERENCES
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