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Comparison of the Polymerization Effectiveness Between the Blue phase 20i Curing Light and A Generic Lamp Manufactured in China

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Abstract

Polymerization is a process that involves the intermolecular bonding of composite resin by light curing, therefore, it is crucial to have a device that meets characteristics that allow adequate light curing, i.e., optimal curing of the material. The main objective of this paper was to evaluate the effectiveness of polymerization using two light-curing lamps: the Bluephase 20i and a generic Chinese-made lamp. In this paper, a qualitative-quantitative approach was employed, using a descriptive cross-sectional research design. Methodological and systematic procedures were conducted, which included a documentary analysis through an exhaustive literature review of previous studies published in certified academic journals. Articles were selected from 2014 onwards, which addressed the characteristics of the lamps under study. The results obtained revealed that to achieve adequate light curing, the lamp used must have an irradiance equal to or greater than 400 mW/cm², a wavelength ranging from 400 nm to 515 nm, with a minimum penetration action of 2 mm to ensure good depth curing capacity. In addition, it was found that the width of the lamp should be between 9 mm and 11.6 mm to obtain optimal light curing.

Keywords: L*ight curing light, Bluephase 20i, Polymerization, Intermolecular bonding*

1. Introduction

For modern dentistry, the use of photopolymerization lamps for dental materials is of great importance, since it is the most used restorative technique in the intervention to solve the problems caused by dental caries. It has been determined that polymerization is a term used when certain materials possessing low levels of molecular weight are presented, which in most cases tend to show a liquid appearance, however, with a luminous action, these materials generate a noticeable increase in their molecular weight, transforming to a solid state, that is, it goes from a monomer state to a polymer state.

In addition, every polymerization process consists of 3 main stages. The first stage is initiation, where it is determined that after the creation of a free radical it is necessary to diffuse in the resin environment, to search for places with electrons, to generate a carbon collision, and initiate the effect of polymerization. The second stage is known as propagation, where the free radical of the monomers entangles other monomers, binding covalents for the formation of polymers, generating an increase in

viscosities and a decrease in their diffusion. Termination is a stage that occurs once the free radicals end, so that the final chain joins its ends to stop some growth of that chain.

Within a photopolymerization process, both the technique and the lamp used play a fundamental role in the final results obtained; When talking about the technique to be used, the orientation focused on the optical fiber and the time spent must be taken into consideration; while in the case of the lamp its intensity, the length of its wavelength, in addition to the optical fiber are taken into account.

It is worth mentioning that the characteristics that a suitable lamp must have to carry out the photopolymerization highlights the level of power that its light presents; the duration of the bulb; weight level; the depth of the curing, since this must be the maximum, and finally the ease of use is highlighted; However, the presence of an adequate wavelength and even light intensity is of paramount importance.

From past decades to the present, several types of lamps used in photocuring have been created to obtain an adequate photopolymerization of the materials used in the dental field, highlighting that among the first creations are ultraviolet light units, visible light systems, halogen light units, Argon laser and plasma arc.

Currently, photocuring lamps have been developed based on LED light units, which are composed of semiconductor diodes for the emission of light when passing through electric currents; The first generation of this type of lamps demonstrated its ability to generate an adequate wavelength and accurate performance for those exposures of long duration; the second generation, was characterized by having LED lights of high emission but with a smaller size, improving its radiation and even the times for healing; and finally there is the third generation, being possessed of LED lights of powerful intensity due to the combined use of several emission units of blue / violet lights, generating greater benefits in the polymerization of dental materials.

Due to technological advances in polymerization lamps that incorporate LED lights, the market has incorporated this type of systems, prioritizing them thanks to their high benefits in the photopolymerization of materials used in dentistry, so it is identified that among the best lamps are the Ivoclar Vivadent, which include models such as the Bluephase 20i, the Bluephase G2 and the Bluephase Style 100-240V.

It has been identified that dental materials when exposed to an LED light emitted by powerful polymerization lamps, as is the case of the Bluephase 20i, benefit the generation of immediate polymerizations that oscillate 10 seconds, increasing the level of absorptions to the maximum of light spectra, reaching 385 nm – 515 nm approximately, which ensures the activation of the various photoinitiators and the depth with which healing occurs. On the other hand, it is also clarified that generic Bluephase 20i lamps provide the same benefits in the dental field, however, their range of spectra is smaller, so the duration of their application should be longer.

The most used materials to perform a polymerization are the photoinitiators of canforquinone the same that is sensitive to the spectrum of visible light, in addition to not needing a coinitiator since they degrade in multiple radicals and one of its advantages is that they are clarified when passing the photocuring process; Composite resin is also used, which can be of different types such as quartz, colloidal and glassy silica that are made up of barium, strontium and zirconium.

The authors have shown that in the first generation of LED lamps only canforquinone could be polymerized and not other types of photoinitiators, however, in the latest generations of photocuring lamps it is evident that they have the poliware capacity allowing polymerize a wider scale of photoinitiators, among the lamps that have this function is the BluePhase family of Ivoclar Vivadent, VALO (Ultradent Products) and the SmartLite Max (Dentsply Caulk).

This article aims to determine the polymerization effectiveness of photocuring lamps between Bluephase 20i and generic Chinese-made.

2. Materials And Methods

The present study was based on a mixed research approach that combined qualitative and quantitative elements to address the issue of polymerization of photocuring lamps, specifically comparing

Bluephase 20i lamps with Chinese generics. This combination of approaches allowed to obtain a more complete and enriching perspective of the problem under study.

The qualitative approach was used to explore and understand in depth all aspects related to the polymerization of light curing lamps through a comprehensive literature review, various sources of information were collected and analyzed that provided detailed knowledge on the characteristics, performance and key considerations in relation to both types of lamps. This literature review allowed to establish a solid base of theoretical and conceptual knowledge that supported the comparative analysis.

On the other hand, the quantitative approach was used to collect and analyze numerical and statistical data related to the depth and exposure time needed to achieve complete polymerization in the resins using the two different lamps. These data were obtained by measurements and experimental tests carried out in a controlled environment. The systematic recording of quantitative data allowed objective and accurate comparisons between lamps to be made, providing scientific evidence to support the study's conclusions.

The combination of qualitative and quantitative approaches in this research allowed to obtain a deep and rigorous understanding of the effectiveness of polymerization in photocuring lamps, providing both a theoretical and empirical perspective this mixed methodology strengthened the validity and reliability of the results obtained, thus enriching the quality and relevance of the findings of the study.

Type of Research Design

Regarding the type of research design, a non-experimental approach was used. This means that the study was based on the collection and analysis of existing information, without direct manipulation of variables or testing in a controlled environment.

To obtain relevant information about Bluephase 20i lamps and Chinese generic lamps, a comprehensive review of scientific articles and specialized sources was carried out. This literature review made it possible to collect detailed information on the characteristics, performance and other relevant aspects of both lamps.

The non-experimental approach used in this study made it possible to take advantage of the already established scientific foundations and previous research in the field of light curing lamps. Through the literature review, it was possible to obtain a solid view of the existing knowledge and it was possible to evaluate and compare the lamps based on this information.

By using a non-experimental approach, greater efficiency and speed in obtaining data was achieved, since the previous work of other researchers was taken advantage of and the need to perform tests in a specific laboratory or research environment was avoided. However, it is important to take into account the limitations inherent in the non-experimental approach, such as dependence on the quality and availability of the information reviewed and the lack of direct control over the variables investigated.

Type of Research by I’ts Scope

Descriptive: The descriptive approach allowed to thoroughly examine and analyze the characteristics, performance and other relevant aspects of both lamps in terms of their ability to achieve effective polymerization. We sought to gain a clear understanding of how these lamps perform in terms of their light power, wavelength, light distribution and other technical characteristics relevant to the photocuring process.

Through the detailed description of the characteristics and performance of Bluephase 20i lamps and Chinese generic lamps, it was intended to provide a complete and accurate overview of their differences and similarities in terms of polymerization. Information was collected on irradiance achieved, wavelength emitted, curing depth, spatial distribution of light and other key characteristics influencing polymerization effectiveness.

By using a descriptive approach, it was possible to obtain a detailed and contextualized image of the photocuring lamps under study. This provided a solid basis for the comparison and analysis of the

lamps, allowing to identify their advantages and disadvantages in terms of the effective polymerization of dental materials.

Theoretical Level Methods of Knowledge

This scientific article will contain the following methods:
Historical – Logical: The evolution of polymerization methods and Bluephase 20i lamps and Chinese generics was identified.
Inductive – Deductive: All the advantages and disadvantages of polymerization with Bluephase 20i and Chinese generic light curing lamps were established.
Analytic – Synthetic: This method helped to establish all those themes related to Bluephase 20i and generic Chinese light curing lamps.
Systemic approach: We proceeded to the organization of all the information collected for the establishment of conclusions and recommendations on the subject.

Research Techniques

Documentary analysis: Scientific literature of the recommendations of the experiences in photopolymerization and the information provided by the manufacturer of each of the lamps to be compared was reviewed, which will allow the correct manipulation of the artifacts involved in the study.

Research Tool

Available literature: systemic review of scientific evidence, which demonstrates the essential characteristics for a correct photopolymerization. Search strategy: The data collection was through articles and scientific research that relate to the subject from 2014 onwards, the same that consist and have been presented in academic and certified journals such as Scielo, Revista Médica odontológica Mexica, Dialnet, these studies show the effectiveness of Bluephase 20i photocuring lamps and Chinese generics. Selection criteria: For the literature review, the inclusion and exclusion criteria were established to determine the data that are appropriate for the present study.

Inclusion Criteria

Information validated by authors of recognition about the research was included. Articles from high-impact scientific journals from 2014 to the present on the results obtained on the effectiveness of the polymerization of photocuring lamps between Bluephase 20i and generic Chinese-made lamps stand out. Among the keywords that were included to carry out the bibliographic review were: Bluephase 20i, Woodpecker, led lamps, photocuring lamps, polymerization, temperature, wavelength, light power, light intensity, polymerization depth, photocuring. Photopolymerization materials: composite resin, bulk filk. Thesis of uses of LED curing lamps with comparative studies between types of lamps

Exclusion criteria

Within the exclusion criterion, the data regarding the previous years before 2013 will not be part of the study, in addition to other types of light curing lamps other than those mentioned for the study.
The LED lamps not studied were of Japanese and German elaboration, different from their origin to the study as is the Chinese brand. Halogen lamps, plasma, laser, ultraviolet light. Comparative studies of hardness, microhardness of the composite resin in Polymerization

3. Results and Discussion

In the literature review of studies conducted on the effectiveness of polymerization of photocuring lamps between Bluephase 20i and a generic lamp of Chinese manufacture, a total of 28 relevant articles were identified. These studies addressed several variables related to the effectiveness of both types of curing lamps. Mentioned below are some of the variables that were established in the articles:

Intensity of the emitted light: The intensity of the light emitted by the photocuring lamps, both the Bluephase 20i and the generic lamp of Chinese manufacture, was evaluated. The power output of the light was measured and compared between both lamps.

Duration of exposure time: The exposure time necessary to achieve an adequate polymerization of dental materials was analyzed. The efficacy of the Bluephase 20i and the generic lamp in terms of required exposure time was compared.

Depth of curing: The ability of photocuring lamps to achieve adequate polymerization at different depths of dental material was evaluated. The ability of the Bluephase 20i and the generic lamp to achieve complete curing in different material thicknesses was compared.

Uniformity of polymerization: The ability of photocuring lamps to achieve uniform light distribution and homogeneous polymerization over the entire surface of the dental material was investigated. The uniformity of polymerization between the Bluephase 20i and the generic lamp was compared.

Clinical effectiveness: The clinical effectiveness of light curing lamps was evaluated in terms of treatment success, durability of restorations and quality of the final result. The clinical results obtained with the Bluephase 20i and the generic lamp were compared.

These variables were analyzed in the different studies identified in the literature review, which allowed to obtain relevant information on the comparative effectiveness of the Bluephase 20i and the generic lamp of Chinese manufacture in the polymerization of dental materials. The results of these studies provide scientific evidence to guide the choice and appropriate use of light curing lamps in clinical practice.

Table 1. Review of articles on the effectiveness of polymerization

Variable	Number of articles
Features of curing lamps	19 of 28 items (1,2,3,7,11,12,13,14,16,17,18,19,20,21, 22,23,24,25,26)
Factors involved in 21 of 28 articles involved in (1,2,4,6,7,8,9,10,11,12,13,14,16,17,18,19,20,21,22,23,24) polymerization	
Advantages	8 of 28 items (1,2,3,4,5,13,12,17)

During the review of the 28 articles, studies were found that addressed the characteristics of photocuring lamps, the factors involved in polymerization and the advantages associated with these devices. The following is a summary of the results obtained:

Characteristics of photocuring lamps: The articles (1, 2, 3, 7, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26) analyzed the characteristics of different curing lamps, including the intensity of the emitted light, the wavelength, the duration of the exposure time, the uniformity of the distribution of the light and the efficiency of the polymerization.

Factors involved in polymerization: The articles (1, 2, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24) examined factors influencing polymerization, such as light intensity, exposure time, distance between lamp and material, quality of emitted light, the composition of the material and environmental conditions.

Advantages of photocuring lamps: The articles (1, 2, 3, 4, 5, 13, 12, 17) highlighted several advantages associated with photocuring lamps, such as faster and more efficient polymerization, greater curing depth, the ability to polymerize different dental materials, comfort of use and the possibility to control and adjust light intensity.

These findings provide a comprehensive view of the characteristics of photocuring lamps, the factors influencing polymerization and the advantages they offer. The results of these studies are important for understanding and optimizing the polymerization process in clinical practice, which can have a significant impact on the quality and durability of the dental materials used. Disadvantages 9 of 28 items (1,2,4,5,11,13,15,17,21)

	Bluephase 20i Woodpecker Generic China
irradiance	2000 -2200 850-1000 mW/cm mW/cm
Wavelength	380-515nm 420nm-480nm
Polymerization time for composites	10 sec / 5-40sec
Tetric polymerization times	5 sec

Light ducts	10 > 8 mm black

During the review of the 28 articles, studies were also found that mentioned the disadvantages associated with photocuring lamps, especially compared to the Bluephase 20i, Woodpecker lamp and generic Chinese-made lamps. Below are the disadvantages mentioned in the articles:

General disadvantages of photocuring lamps: The articles (1, 2, 4, 5, 11, 13, 15, 17, 21) mentioned some common disadvantages of light curing lamps, such as the need for an external power source, heating during prolonged use, and possible heat generation in dental material.

Bluephase 20i: Some specific disadvantages of the Bluephase 20i lamp compared to other lamps were mentioned, such as a lower irradiance (2000-2200 mW/cm²), which could affect the polymerization efficiency, and a wavelength of 380-515 nm.

Woodpecker lamp: Some specific disadvantages of the Woodpecker lamp were mentioned, such as a lower irradiance (850-1000 mW/cm²) compared to the Bluephase 20i, which could influence the polymerization efficiency, and a wavelength of 420-480 nm.

Chinese-made generic lamps: Specific disadvantages of Chinese-made generic lamps were mentioned, such as longer polymerization times (between 5 and 40 seconds for composites) compared to the Bluephase 20i, and light ducts of smaller diameter (8 mm) and black color, which could affect the efficiency and uniformity of polymerization.

These disadvantages mentioned in the articles point out some aspects to consider when using light curing lamps in clinical practice. It is important to take these limitations into account in order to make informed decisions about the use of photocuring lamps and to ensure effective and quality polymerization in the dental materials used.

It should be mentioned that one of the features of Chinese generic light curing lamps feature an eye protector and an optical fiber; which is important its use to avoid eye damage in the professional, which is considered a barrier to radiation of 420nm which are harmful; It also serves so that the lamp does not come into contact with contaminants. While the Bluephase lamp is an LED lamp with characteristics of having an anti-glare cone which allows to protect the eyes from prolonged exposure of the lamps helps to reduce the reflection of light and a 10 mm light duct that allows accessibility of all areas of the restoration, The large cavities facilitate the irradiation of light, so it can be mentioned that both Chinese generic light curing lamps and the Bluephase lamp have eye protection characteristics. Generic lamps include an eye shield and fiber optics, while the Bluephase lamp features an anti-glare cone. Both designs seek to safeguard the visual health of the professional and ensure a safe working environment. In addition, the Bluephase lamp stands out for its 10 mm light duct, which facilitates access to all areas of the restoration, ensuring efficient and complete irradiation for successful photocuring.

Factors Involved in Polymerization

There are several factors involved in polymerization which are related to the material, those related to the characteristics of the lamp to be used such as wavelength, distance, intensity and exposure time, even the technique used for dental restoration.

Wavelength

Within the dental materials for definitive restorations, the most used is canphoquinone that to be activated the wavelength must be 420 - 495nm, however, alternative photoinitiators usually require a length less than 420nm. At present, more effectiveness has been shown in bulk fill resins, which requires an absorption spectrum of 390 – 510 nm. (18)

Light Intensity

The irradiance of the LED lamp to have an adequate photocuring must be equal to or greater than 1000 mW / cm2, however, it should also be considered that the higher the irradiance, the shorter the exposure time; the authors recommend that the minimum light intensity to perform a polymerization process is 400 mW/cm2. (15,19,29,30))

Studies indicate that contamination is an irradiance enhancer, Reategui et al. (8) studied 153 lamps including Chinese brands and Bluephase where it was evidenced that when the lamp is not contaminated it does not reach a recommended power, however, 91.5% of contaminated lamps showed that it achieves a recommended power. Another author pointed out that the power increases by 67.11 mW/cm2.

Regarding the use of protective barriers when working with LED lamps, it was evidenced in a study that dental centers must guarantee the safety and health of the patient where 91.5% indicated that they do not use a protective barrier (8); García et al. (16) points out that when using protective barriers

The patient is protected by 96% to prevent cross-contamination, also reducing microbial loads, so it is recommended to perform a pre and postoperative cleaning. (31,32,33)

A study conducted by Sierra (1) examined the effectiveness of Chinese-made generic curing lamps. In this study, tests were carried out on a total of 161 lamps to evaluate their performance in relation to the parameters necessary to achieve adequate photopolymerization.

The results revealed that, in order to obtain an optimal result in the photopolymerization process, the lamps must meet two basic requirements, firstly, it is crucial that the irradiance of the lamp is equal to or greater than 400 mW/cm². This implies that the lamp must emit an adequate light intensity to ensure efficient polymerization of dental materials.

In addition, it was found that the wavelength of the light emitted by the lamp must be within a range of 400 nm to 515 nm this range of wavelengths is particularly effective in activating the initiators of the resin and triggering the polymerization reaction. Proper wavelength selection ensures proper photopolymerization and good curing quality in the dental materials used.

However, the study also revealed that only 50% of the lamps examined met these fundamental requirements, indicating that a significant proportion of the Chinese generic curing lamps tested did not offer adequate irradiance or wavelength to ensure effective photopolymerization. (34,35,36)

In another study by Reategui et al. (8), the light power achieved by different photocuring lamps was evaluated, specifically the Woodpecker lamp and the Bluephase lamp were compared, the results revealed that the average light power obtained with the Woodpecker lamp was 1066.40 mW / cm², while the average light power with the Bluephase lamp was 1454.17 mW / cm².

These findings clearly demonstrate that, when comparing only these two lamp brands, the Bluephase lamp outperforms the Woodpecker lamp in terms of light output achieved. Light power is a crucial factor in the photopolymerization process, as higher light intensity ensures a more efficient and complete polymerization reaction in dental materials. (37).

The fact that the Bluephase lamp has proven to have a higher light output on average positions it as a favorable option for achieving effective polymerization. However, it is important to consider that other factors can also influence the overall effectiveness of photocuring, such as wavelength, light distribution and exposure time.

4. Conclusion

When carrying out the bibliographic review, it is concluded that to have an effectiveness in polymerization the most appropriate lamp is Bluephase 20i due to its characteristics such as the light intensity of mW / cm2 allowing to use a shorter exposure time in the curing, being an advantage in the working time of the treatment.

According to the research carried out by other authors, a generic lamp of Chinese manufacture can be used to perform a polymerization, however, its effectiveness is only 50%, since more exposure time must be used due to its low irradiance; In addition to photocuring only a depth of polymerization up to 2mm, making it impossible to photocure in restorations with more depth.

It is also verified that the Bluephase 20i lamp works better with bulkfill composite resins giving a homogeneous finish in the photocuring process, having a high degree of conversion; Always remembering to use the parameters established by the manufacturer of each product to obtain the required results in polymerization.

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