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“Quantum Jump” and Their Effects on the Photo Whitening Technique

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Abstract

Recent research on tooth whitening aims to optimize whitening while minimizing its side effects, such as tooth hypersensitivity and damage to the soft and hard tissues of the oral cavity. Various research with methodology using colorimetric and spectrophotometric tests shows that the technique applying violet light, with a wavelength of 408 nm, produced better results than other sources normally used in tooth whitening. Scientific findings prove the results that simultaneously applying dental whitening in the office with transparent/colorless gels and violet LEDs allows the light to interact directly with the pigments, increasing the oxidation effect with the peroxide itself. So, there is a double effect: the photochemical action with the oxidation molecule with the peroxides promoting the optimization of the traditional use of chemical agents. This short communication aims to highlight the advantage of using violet light and provide more physical and chemical information about this whitening process. This is a new technique, without producing heat, roughness or sensitivity, with comfort and safety for the patient and professional. We can conclude that new studies become relevant for the evolution of this technique.

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Introduction

If we carefully analyze whatever happens in nature, we will end up for reaching the microscopic nature of things. In fact, it's all about atoms and molecules. At this point, our daily intuition is no longer valid. To really understand things, it is necessary to have recourse to the quantum nature of matter, and therefore the phenomena are behind important effects and techniques that are now inherent to the dentistry. Incredibly, composite healing and photo-activated teeth whitening these are procedures routinely linked to such effects. Among the consequences of the quantum nature of the molecules is the fact that the spatial distribution of the charge electronics (electronic space occupation) in atoms or molecules occurs only in some possible configurations. These configurations are called quantum states of the electron at the microscopic level.

These spatial configurations of negative charge are the main ones responsible for chemical bonds, which determine the structure of the microscopic of molecules, how they stay together with others, and the most important, its various properties. The color, the electrical properties, and everything else depend on these structures. An important property of quantum nature is that, with only a few of these possible distributions, changes are only allowed when there is a jump from one setting to another. These jumps are called “Quantum Jump”. The occurrence of these jumps can cause structural changes, modification of the reactivity and even a rupture of bonds causing fragmentation of molecules.

What physical phenomena cause these "Quantum Jump"? Many effects can cause it. Collisions between external electrons with these chemical bonds, excessive heat, or most importantly: the interaction of molecules with light. To understand This, it is necessary to understand about light. From a quantum point of view, light is composed of a collection of packets of energy called photons. The interaction of these photons with the electronic structure can promote orbital changes and thus “Quantum Jump”. A "Quantum Jump" occurs each time a molecule absorbs a photon. At this point, we must also say that the opposite is true: spontaneous modifications in the charge distribution also cause photon emission.

The higher the frequency of light (its frequency increases from red to violet), the higher the photon's energy. Often high-energy photons can cause the molecule to break down. That's the principle of promoting the polymerization of the resin by creating chemical bonds that bind the individual molecules. At the molecular level, whenever the fragmentation of a molecule, its properties, including its color, can be severely altered. Here lies the connection of what we have reported about photo whitening. The basic principle of teeth whitening is related to the combination of physical and chemical effects that alter the interaction of light with the pigmented molecules, giving the observer an effect whitening. Let's explain this part a little better. When white light interacts with the structure of the teeth, they undergo diffusion, reflection in such a way that part of this light returns to our eyes. The sensation of color we have depends on the ability of the light/tooth interaction in modifying the original blue of the light. The feeling of white (interpreted by our vision system) implies the correct balance of blue-red-green. The presence of pigmented molecules in the tooth structure absorbs the component blue of light. In this situation, the original white light returned is depleted from the blue and acquires the yellowish tone (predominant red-green composition). Yellowing of the tooth, caused by pigmented molecules, it is totally a consequence of the lack of blue in the light that we observe. The pigments absorb the blue part of the light and absorb it severely the violet.

Materials and methods

Thus, we justify the action of 408nm violet light, at a total delivered power of 1400 mW, 165 mW/cm^2, breaking down molecules pigmented organic lesions present in the tooth structure[1] the breakdown of molecules, modifies the distribution of charges (mentioned above) by ceasing the absorption of blue light from the incident white light. At this point, the color of the tooth, as observed by our eyes change. That's photo whitening in action. Consequently, the fundamental mechanism of teeth whitening can be chemical, when peroxide-mediated reactions cause alteration in the molecules of pigment, usually induced by the whitening gel or physical, through violet light.

Results and discussion

What really matters is that the tooth pigment is fragmented, which will restore the ability of the tooth structure to return white light without modification. Thus, the balanced mixing of green, red, and blue colors allows the observer to see the Whitening of the tooth surface. Photobleaching occurs essentially through quantum jumps of electrons that, when they decay, generate violet photons, strong enough to fragment pigmented molecules. There seems to be no doubt that it is possible achieve the same effect using light as that obtained by using chemicals. The light violet has a short wavelength, very close to ultraviolet, but it is the ultraviolet that is well known for causing damage to DNA or proteins, and the violet light don't cause damage to the human cells. The use of violet light at moderate power and short exposure time is totally safe for biological tissues in general, being harmful only to pigmented molecules. Studies have shown that violet light is able to break down pigments in teeth whitening without the need to compound with gels based on peroxides.[1][2][3][4][5]

Other studies show the association of peroxide with violet light producing better effects when compared to teeth whitening techniques already with or without light[4][6][7]. Violet light has strong absorption by chemical bonds present in the molecules pigmented. The light energy transferred through the photons promotes a transition or quantum modification in these electronic clouds, causing bonds to π and π* to become modify to an unstable situation, promoting the dissociation of these molecules. Breaking down the molecules that stain the tooth, as mentioned earlier in this text, promotes teeth whitening. The equivalent process also occurs in plastic pigmented or dyed when exposed to sunlight for prolonged time. We just do the use in teeth whitening controlling application in a short period of time.

Recent research on this topic aims to improve whitening minimizing its side effects, such as dental hypersensitivity and damage to the soft and hard tissues of the oral cavity. There are many articles already produced, and the research is still ongoing.[1][2][6] Collaboration with researchers from other institutions renowned companies point out that currently teeth whitening using violet light with or without peroxide gels in different concentrations is the most innovative technique for the teeth whitening as well as the one with the fewest side effects in dentistry aesthetics.[4][7][8] Colorimetric and spectrophotometric tests were performed and suggest that this violet system, with a wavelength of 408nm, produced better results than other sources usually used in teeth whitening. Findings similar statistics were obtained when

associating violet LEDs with peroxide 38% hydrogen (HP) or 30% carbamide peroxide (CP), which releases only 10%[8] This study by Klaric *et al.*[9] scientifically proves the results we have obtained simultaneously in-office teeth whitening with gels transparent/colorless and violet LEDs[4][5][6] matching transmission of this length through the enamel and dentin, allowing the light to interact directly with the pigments increasing the oxidation effect with the peroxide itself. So, there's a double effect: the photochemical action with the oxidation molecule with the peroxides promoting the optimization of the traditional use of chemical agents.[10][11][12][8] This is another advantage for the use of violet: The use of low concentration gel with the advantage of eliminating unwanted effects of concentrated hydrogen peroxide on enamel, dentin, soft tissues, and restorations. It is a new option in teeth whitening, without producing warmth, roughness, or sensitivity, with comfort and safety for the patient and professional.

In addition to the great advantage for whitening, the use of violet light associated with antimicrobial drugs have been investigated by our group and have shown positive results in gingivitis and oral decontamination in general. A new application of light violet in Dentistry as an antimicrobial and photocoagulation tool has been corroborated by our clinical research.[13] The bleaching protocols developed by our group are based on the use of violet light with the characteristics of 408nm, at a total delivered power of 1400 mW, 165 mW/cm^2. The results indicated that, when associated with peroxide solution or gel, the use of violet light promotes an effect teeth whitener after a short clinical session in the dental office, decreasing pain sensitivity during and after the clinical procedure. That indicates less physical aggression to the tooth surface, no aggression to the oral soft tissues and it allows for more frequent clinical sessions without harming teeth or soft tissues.

The fundamentals of photonic whitening with violet light are based on the quantum mechanics, which is fully accepted by modern science.[12][8][13] Therefore, the foundations of quantum mechanics. Scientific studies of photobleaching with violet light are consolidated as the processes[8][13][14][15][16] Dentistry profits from the fact that violet light (λ~408nm) has enough energy to break down the pigmented molecules normally associated with to the cause of yellowing teeth. Because it is safe, and has a consolidated scientific basis.

Conclusion

Dentistry must experiment and prove new protocols not yet proposed in the literature. The Influence of light in new processes and the interactions of lasers and LEDs with tissues must be studied and discussed in the light of real science and not in the ambiguous suspect hypothesis. Ago always room for improvement and amplification of the effects. That's what dentistry modern should be doing. The concealment of real effects does not improve or evolve the field of this subject.

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