INFLUENCE OF DIFFERENT PHOTOACTIVATION METHODS ON THE LONGEVITY OF RESTORATIONS WITH COMPOSITE RESIN IN NON-CARIOUS CERVICAL LESIONS: LITERATURE REVIEW

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ABSTRACT

Non-carious cervical lesions (NCCL) are among the most frequent conditions affecting dental structures and although restoration with composite resins does not directly treat the etiology of this condition, it replaces the lost dental tissues, restoring the structural integrity of the teeth. The restorative treatment also contributes reducing the dental wear and hypersensitivity of dentin, when present, further improving the aesthetics. Despite of the benefits briefly presented, the longevity of NCCL restorations still an issue nowadays because of problems related to the material's retention in the cavities. This study aimed to evaluate whether different methods of light curing interfere on the longevity of these restorations. Therefore, there was collected information from scientific papers, course papers and master's dissertations were searched in online databases, as well as chapters of books related to the research theme. Then a discussion of the different photoactivation techniques and light intensities was carried out, comparing the positive and negative effects related to microfiltration and to marginal adaptation, as well as the advantages and disadvantages in order to promote satisfactory results in long-term of NCCL restorations.

KEYWORDS: Noncarious Cervical Lesions. Curing Lights. Composite Resins.

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INTRODUCTION

Numerous clinical researches have been developed to investigate the performance of adhesive systems in relation to the longevity of restorations in non-carious cervical lesions.[1,2] Although the adhesive systems used are more important, the photo activation technique can also influences the clinical performance of the restoration, since the polymerization reaction influences the interaction of the molecules, reducing the fluidity, changing the volume and increasing the rigidity of the restorative material. These changes may result in internal stress variations, forming cracks between the restoration and the tooth.[1,2] The shrinkage of the composite resin can be divided into two: pre-gel in which volumetric change can be compensated by the flow of the material and post-gel in which the formation of the polymer is accompanied by the development of the modulus of elasticity.[3] As a result of this shrinkage, stresses begin to increase which may lead to failure of adhesion and / or deformation of the surrounding dental structure, resulting in microcracks in the cervical enamel and predisposing the tooth and / or restoration to the fracture.[4]

Depending on the light intensity, an increase in the elasticity modulus of the material may occur, leading to a greater polymerization shrinkage and resulting in clinically negative effects such as: leakage, marginal discoloration, tooth and / or restorative material fracture, post operative sensitivity and recurrent caries [1,5]. Thus, from the 90's onwards, several researchers have suggested the reduction of light intensity at the beginning of resin photo activation and several techniques have been developed in an attempt to minimize the effects of polymerization shrinkage.[1,4-6]

The suggested techniques using low light energy levels at the start of polymerization exposure[3,5] can be divided into ramp or soft start. In the first one the photo activation begins with low intensity of light during the first 10 seconds, followed by total intensity for complete polymerization; in the second technique light intensity gradually increases over a short period of time.[3,5,6] There are authors who have used these techniques to verify the effect on longevity of NCCL restorations, but there is still no consensus on the long-term effect of the different polymerization techniques of these restorations.[27,28,45,54,62,63]

Therefore, the purpose of this review was to analyze whether different photo activation techniques influence the longevity of restorations of non-carious cervical lesions.

MATERIALS AND METHODS

The present study was carried out through a literature review and studies analysis. The reflections and discussions are based on the theoretical reference on the influence of polymerization techniques on the longevity of restorations of non - carious cervical lesions.

Data collection was carried out from March to November 2018. Scientific papers, course completion papers and master's thesis were searched, with records inserted in online databases: online libraries, Latin American and Caribbean Literature in Health Sciences (LILACS), Scientific Electronic Library Online (SCIELO), National Library of Medicine (PUBMED), Google Scholar, as well as chapters of books related to the research theme. We included studies published between the years 2010 to 2018, using the following keywords: "photo polymerization", "class V "Non-carious lesion"; "Composite resin"; "Photo activation". Keyword associations were made using the Boolean search operators criteria (and, or or not). From the total of articles found, 62 were selected read and summarized. The exclusion criteria was studies that showed the effectiveness of different adhesive systems, and the inclusion criterion was those that contained researches with different types of light sources and photo activation methods in composite resin restorations in non-carious cervical lesions.

LITERATURE REVIEW

NON-CARIOUS CERVICAL LESIONS

Non-carious cervical lesions (NCCL) are associated with pathological processes of loss of dental structure in the cervical region and may vary in etiology and clinical presentation, manifesting as erosion, abrasion or abduction.[7] Abfraction is the loss of dental structure by repeated pressure on the teeth. The etiological factor may be related to the eccentric occlusal forces, giving a wedge-like aspect in the cervical region of the tooth. Abrasion is related to the loss of tooth structure due to a mechanical process, such as the type of toothbrush, the brushing technique and the use of abrasive dentifrices, resulting in concave-shaped lesions. Erosion is the loss of dental structure due to the action of chemical substances causing shallow, broad, smooth and polished lesions on the dental surface.[8] Loss of dental integrity of non-carious origin may lead to aesthetic limitations and, in extreme cases, to dental fractures.[9]

NCCL can affect any tooth and any face since it is not occlusal[10], but studies show that the higher prevalence in certain areas depends on the etiological factor. Yamashita et al. (2014)[11] found a higher prevalence of lesions in the first premolars, followed by the second premolars and first molars. NCCL in wedge form and cervical dentin hypersensitivity (CDH) are primarily observed on the buccal or lingual surfaces.[12] Canines, premolars and first molars that have prolonged contact with the toothbrush and receive greater force intensity during brushing, present a strong correlation with friction. Likewise, NCCL in the posterior teeth are frequently related to excursive occlusal interferences; lateral movements involving premolars or molars without contact with the canine can be detrimental to the posterior teeth. The presence of lesions in the lingual region of the anterior teeth indicates the probable biocorrosive etiology and the presence of isolated lesions in the arch may be strongly related to biomechanical factors.[10] Subgingival lesions are more related to stress, biocorrosion and anatomical predisposition of the patients, such as absence of cementum-enamel junction.[10]

According to Gallien et al. (1994),[13] the abrasion injuries are caused by the destruction of the dental structure by food, brush bristles and toothpaste. They are presented as concave lesions with a smooth texture and are found on the buccal surfaces of the teeth.[13] In agreement with Spigset (1991)[14] and Gallien et al. (1994)[13], erosion is characterized by the loss of enamel and, subsequently, of dentin on the buccal and lingual surfaces of the teeth by external chemicals such as acidic beverages. This loss of enamel and dentin may be exaggerated by the influence of abrasives, particularly the association with toothbrushing using dentifrices.[14,13] According to Spigset (1991)[14], enamel erosion is probably the largest oral manifestation of bulimia due to regurgitation of gastric contents. These lesions appear broad and without defined borders. Abfraction results from traumatic occlusal forces that cause dental bending and alter enamel, dentin and cement, far from the site of traumatic occlusion. It is characterized by the loss of tooth-shaped structures in the cervical region, where the primary factor is excessive occlusion loading. The cracks tend to be perpendicular along the axis of the tooth of characteristic angular shape.[15,16]

HYPERSENSITIVITY

Dentin hypersensitivity is a relatively common condition in clinical practice. Its development depends on the existence of two conditions: the exposure of dentin and the opening of the dentinal tubules, being etiologically associated with the phenomena of abrasion, erosion and possibly abfraction.[8] The presence of dentin hypersensitivity is explained by the hydrodynamic theory of Branstrom (1986)[17] based on the findings of Gysi (1900).[18] According to tis theory, the presence of cervical lesions, when loss of enamel and / or cement, and consequent opening of the dentinal tubules to the oral environment, under certain stimuli, allow the dental fluid to move inside the dentinal tubules, indirectly stimulating the extremities of the pulp nerves and provoking the sensation of pain.[17]

For a correct diagnosis it is necessary a detailed anamnesis, associated to a clinical and radiographic examination that allows to differentiate the dentin hypersensitivity of the other pathologies that affect the teeth. The dentin hypersensitivity may present spontaneous healing, by remineralization by saliva or by the formation of reactive dentin. The definitive treatment would be one that reduces or prevents the movement of fluids in the dentinal tubules.[19]

Regarding the treatment, the first therapeutic measure to be adopted is the removal of causal factors and later in the individual analysis of aspects such as the depth of the lesion and the presence of painful symptomatology, to determine the need of restorative procedure.[20] In cases where there is no need for restoration, there are other treatments such as occlusal adjustment therapies,[21] chemical therapies with the use of desensitizing agents[22-24], and laser therapies.[25,26] If restorative treatment is necessary, there are available materials on the market, such as glass ionomer cement, conventional composite resins[27-32] and ceramic fragments.[33]

RESTORATIVE TREATMENT FOR NON-CARIES CERVICAL LESIONS

After diagnosis and decision making to restore a certain lesion, it is necessary to define the type of restorative material to be used. For this decision one must take into account the potential of the restorative material in reproducing and maintaining the color and texture of the surface in the long term, besides the wear resistance and modulus of elasticity of the material.[20] According to Soares, Quagliato and Campos (2005)[34] restorations to eliminate dentin hypersensitivity can be made with composite resin or glass ionomer cement. For Sobral (2003)[35] when a restorative material is chosen for a cavity, that is, in the presence of an NCCL with sensitivity, one must keep in mind the factors responsible for the formation of the lesion. Currently one of the materials most used is the composite resin due to its mechanical and aesthetic properties.

Aesthetic restorative treatments represent one of the first actions of the dentist for smile enhance. The material of choice in this type of treatment is often composite resin that has little porosity, less staining, better mechanical properties, good color stability, controllable working time and allowing the use of multiple composite colors in a single restoration.[36] An organic matrix containing monomers, initiators, color modifiers forms these composites. Furthermore, the composite resin has the filler particles that are bonded to the organic matrix by the silane coupling agent.[36] For its polymerization to occur the free radical initiator system consists of a photosensitive molecule and an initiating amine. As long as these two components are not exposed to light, they do not interact. However, exposure to light in the blue region of the spectrum (wavelength approximately 468 nm) produces an excitatory state of the photosensitive molecule that interacts with the amine to form radicals that initiate polymerization by addition. Camphorquinone (CQ) is a commonly used photosensitive molecule that absorbs blue light, with a wavelength between 400 and 500 nm.[37] The degree of conversion depends on the efficacy of the radiation, including spectral distribution, light intensity and time of exposure.[38,3] A reduction in light intensity may result in a lower degree of conversion of the monomers and consequently negative clinical implications, such as reduction of wear resistance and hardness, detachment and gap between the composite resin and the cavity walls.[40-42]

The polymerization depth may be affected by several factors associated with the output light, including spectral emission, light intensity, period of exposure and composition of the material.[43] A lower degree of conversion leads to lower wear resistance, lower color stability, and higher degradation, as well as increase fracture rates.[43] Such poor polymerization can lead to consequences such as gap formation, poor marginal adaptation, secondary caries, and restoration failures.[44]

Two important factors for an ideal polymerization and to avoid the consequences of a poorly polymerized resin are: the intensity output light and the time of photo activation. Although a higher light intensity can result in a higher degree of conversion, it can also lead to a greater polymerization shrinkage, which would generate stresses that hinder the connection of the walls of the restoration to the cavity, which is one of the main causes of failure and subsequent micro leakage and marginal discoloration[45]. In this way the literature suggests some photo polymerization techniques such as: soft-start, pulse delay, transdental, Ramped-curing and Stepped-curing.

PHOTO ACTIVATION TECHNIQUES

In this age of sophisticated photo curing units, there are multiple possibilities of photo activation techniques, which offer more options, but also more confusions for dentists. Some photo activation techniques have been proposed to reduce the generated stresses during polymerization shrinkage of composite resins, such as soft-start [4,5,46-48] and pulse delay.[48,49] The soft-start photo activation comprises an initial photo activation with low light intensity for a short period of time, followed by the final high-intensity photoactivation.[5,48] The pulse delay technique consists of the initial photo activation with low intensity, also for a short period of time, followed by a waiting period in which the surface finish can be done, and finalization of the photo activation with high intensity of light.[4,48] The method comprises the photo activation of the last layer of composite resin in two stages. Initially the photo activation is carried out for a short period, with low intensity of light. After a few minutes it complements the photo activation with longer exposure time and more light intensity. This range is designed to decrease the rate of polymerization (delay gel point), allowing composite resin to flow.[5,50,51]

In the soft-start technique the light exposure is made continuously, without interruption.[52] This technique can be done in two ways: the Ramped-curing method or the step-curing method. In both methods, the radiation has low intensity at the beginning and is gradually increased until reaching a higher intensity in which it remains for a longer period of time.[53,54] In the ramp polymerization method the light intensity rises gradually and continuously over time, allowing the composite resin to polymerize more slowly, reducing the stresses. This technique can be performed by devices that have this option of polymerization or by manual approach.[55] In the step polymerization method the light energy automatically increases from low to high intensity. Like ramp polymerization, this method can be carried out by apparatus having such a mode, or by the manual technique.[56]

These photo activation techniques have some peculiarities, which refer to the time and intensity of light employed. The so-called soft-start technique initiates photo activation with a low light intensity – ranging from 17 mW/cm^2 [46] to 400 mW/cm^2 [57] for a few seconds, followed by a final light activation with high intensity – 450 mW/cm^2 [46] to 720 mW / cm^2 [57]. In the so-called pulse delay technique, where low intensity photo activation is initiated – ranging from 100 mW/cm^2 [48] to 425 mW/cm^2 [47], but a period of 3 to 5 minutes is waited, followed by a finishing step with high intensity – 500 mW/cm^2 [48] to 750 mW/cm^2 [48].

The transdental technique is the conventional technique, but with the curing unit tip placed in contact with the dental structure, so that the light needs to cross it to reach the composite resin. The method is based on the concept of gel deceleration of the resin, because as it crosses the dental structure the light intensity is attenuated, which decreases the rate of polymerization. The objective of this technique is the same as that of the slow photo polymerization, that is, to minimize the shrinkage stresses that occur in the tooth-restoration interface.

The slow and transdental photo activation techniques reduce the rate of polymerization by exposing the resin to a lower initial light intensity, which in the end is completed with higher light intensity.[5] Although these techniques do not completely eliminate the problems of polymerization shrinkage stresses, many studies have demonstrated the effectiveness of slow photo activation in improving marginal integrity, reducing micro leakage and its consequences.[1,5,58-60] It should be noted that the improvement of marginal integrity should not be achieved at the expense of a lower degree of conversion, which in turn would mean reduced mechanical properties.[36]

Uno and Asmussen (1995)[5] investigated the effect of soft-start photo activation on marginal adaptation, shear strength and diametral tensile strength of a composite resin. A transformer was coupled to the photo activating apparatus in order to decrease the emitted light intensity, thereby enabling the reduction in the polymerization rate of the composite resin. The results showed that the soft-start technique did not influence the microhardness values and that the mechanical properties had their values improved with the use of this technique.[5]

SAHAFI et al. (2001)[55] evaluated the effect of the pulse delay photo activation technique on marginal crack formation in composite resin restorations. The authors concluded that the late pulse technique can significantly reduce marginal gap, but is not yet capable of eliminating it.[55]

According to Chandurkar et al. (2014)[61], the slow start polymerization mode offers advantage over the standard polymerization protocol in terms of microleakage. The LED light showed less microleakage than the QTH light and although it was not statistically significant. Thus, the soft-start polymerization technique results in lower microleakage when compared to standard polymerization, and therefore may help to improve the marginal adaptation of the restoration.[62] On the other hand, França et al. (2005)[62], observed that the soft-start polymerization did not influence the microleakage of the restorations.

CONCLUSION

Based on the collected data, it is possible to conclude that among the main photo activation techniques used in NCCL restorations, the slow onset seems to be able to reduce the marginal microleakage and to improve marginal adaptation of the restorations. However, the results are influenced by the restorative material and adhesive system used. Therefore, more studies are needed in order to compare all the techniques of photo activation, in order to evaluate the advantages and disadvantages of each one, in order to determine a protocol that can positively influence the longevity of the restorations of non-carious cervical lesions.

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