RESTORATIVE MATERIALS FOR RESTORATIONS OF NON-CARIOUS CERVICAL LESIONS: AN OVERVIEW

Francielly Censi Boehm[1], Caio Junji Tanaka[2]
1 Undergraduate student, UNIC - Cuiabá University, Rua Floriano Peixoto, 597 - 78700-040 - Centro, Rondonópolis - MT, Brazil.

2 Dean of UNIVERITAS School of Dentistry, Avenida Uberaba, 251 - 08573-070 - Vila Virginia, Itaquaquecetuba, SP, Brazil.

CORRESPONDING AUTHOR: caiotanaka@outlook.jp

ABSTRACT

Objective: To review the available scientific literature on the restorative treatment of non-carious cervical lesions; in particular, the restorative materials that present optimal performance in this type of clinical situation.
Methods: A literature review was performed using Pubmed search engine with the aim of determining the ideal restorative material for restorations of non-carious cervical lesions.
Results: Beautifil II (Shofu INC.) restorative material showed satisfactory results in terms of fracture resistance, flexural strength and excellent aesthetics, in addition to components that act as anti-cariogenic, anti-plaque and oral pH balance. The Clearfil SE Bond adhesive (Kuraray NORITAKE) showed in clinical research the highest bond strength rate compared to other adhesive systems available in the dental market.
Conclusion: Non-carious cervical lesions are multifactorial lesions that require the professional knowledge to conduct the treatment effectively. The Shofu Beautifil II showed the best results in fracture resistance, flexural strength and excellent aesthetics, it has anticariogenic potential, anti-plaque bacteria and contributes to the oral pH balance. The Clearfil SE Bond adhesive showed the highest retention rate among its competitors.
Keywords Restorative materials. non-carious cervical lesions. class V.
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INTRODUCTION

Non-carious cervical lesions (NCCL) are commonly found in dental practice. They present as characteristic wear in the cervical area of the tooth, region in which the enamel presents less thickness and therefore becomes susceptible to chemical, physical and mechanical agents. If there is no clinical intervention, this loss of hard tissue may progress to dentin exposure and loss of the cementoenamel junction[1,2].

Its etiology is not related to caries disease; the cause is multifactorial and may affect all age groups, with higher incidence in older people[3]. All teeth can be affected by this lesion, but its prevalence is in upper bicuspid teeth[4]. This pathological wear can compromise pulp vitality, function, aesthetics, as well as cause uncontrolled sensitivity, facilitate the development of caries and hinder the use of removable partial dentures[5].

The NCCLs result from abrasion, erosion and abfraction, and present themselves as small depressions or in the form of grooves but may reach more severe depths in the form of wedges6. Abrasive damage

is caused by friction, such as traumatic brushing and/or toothbrushes, erosion damage is caused by acids of non-bacterial origin, either intrinsic or extrinsic. Abfraction is related to increased occlusal load, developing excessive tension between enamel and dentin from malocclusion, missing teeth, para-functional habits such as bruxism, and concentration of forces in orthodontic treatments[7-9].

The variation in the characteristics and incidences of NCCLs among people is common. This is due to the diversity of causes and the simultaneous association of etiological factors to dental wear. The control and/or elimination should be the first step of the therapeutic protocol. In specific cases, restoration of the site affected by the lesion is necessary[10]. Dursun et al. [11] reported in their research that gingival recession and root exposure may be associated with NCCLs and in these cases periodontal treatment is necessary.

Restorative treatment is challenging when taking into account lesion anatomy, adhesion to sclerotic dentin, load concentration that the cervical region is subjected to, and marginal adaptation[12]. The operative field should be isolated to contain moisture and not have soft tissue interference[13].

Typically, the materials used to NCCLs restorations are resin composites (RC) and glass ionomer cements (GIC). Importantly, restoration longevity is multifactorial and depends on the effectiveness of bonding agents, acid etching, and light-curing methods. Possible failures in these steps can lead to the development of new diseases, such as caries[14].

Conventional glass ionomer cements (GICs), in the category of bioactive restorative materials, have the highest concentration of fluoride release/recharge to the oral environment. Their modulus of elasticity is low, they have ionic adhesion to substrates and biocompatibility. Among their limitations are poor esthetics, high solubility, low attachment rate, low wear resistance, and low flexural strength[15].

Resin-modified glass ionomer cements (RGICs) have resin monomers and photosensitive components in their composition. Besides the advantageous properties of GICs, there were improvements in wear resistance and postoperative sensitivity rate compared to conventional GIC. However, they present mechanical failures when used in areas of load concentration[11,16].

Regular resin composites are preferred choices by clinicians. They have satisfactory esthetic results, marginal integrity, good wear resistance, a variety of color shades, and low long-term failure rates. Their disadvantage is polymerization shrinkage[17,18].

Fluid or flow resins composite (FRC) have low viscosity, low modulus of elasticity compared to regular resin composites, good wear resistance and good esthetics. Their limitations are their mechanical properties[19].

Giomers bioactive resin composites, besides presenting the physical and mechanical properties of regular RC, have the potential to release/recharge fluoride to the oral environment as the GICs, able to induce remineralization and inhibit the formation of caries and have "chameleon" effect incorporating the color tone of the dental element[20].

The aim of this study was to review the available scientific literature on the restorative treatment of non-carious cervical lesions; in particular, the restorative materials that present optimal performance in this type of clinical situation.

LITERATURE REVIEW

For many years researchers have studied the etiology, treatments and prevalence in different populations for NCCL[21]. Knowledge of the clinical features and causative agents, together with the patient's anamnesis, is of great relevance to reach the correct diagnosis of an existing lesion. Intervention in the initial phase avoids the destruction of healthy structures and eliminates the chance of new diseases[1].

In most cases, patients seek dental help when they present hypersensitivity or aesthetic defects[22]. In some cases the sensitivity is moderate because of the accumulation of biofilm, calculus, or gums over the lesion. The removal of this coverage exposes the lesion and leaves it sensitive and vulnerable to the action of biological, mechanical and chemical factors that are associated with the systemic behavior of each individual[19,23].

The presence of pain helps the identification of the problem, in the location of the lesion, and in the therapeutic decision. During the anamnesis and intra-oral examination, it is possible to identify behavioral and eating habits that may hypothesize the development of the lesion. The causes may be erosive wear, abrasive wear and/or abfraction lesion[7,22].

Erosion is defined as a loss of dental hard tissue caused by an acid substance with no bacterial involvement, with extrinsic origins related to the consumption of acidic and citric beverages and foods, or intrinsic from gastric acids generated by eating disorders[24,25].

Abrasion results from frequent contact and excessive forces on teeth with objects or substances, without interference from occlusal force, such as: traumatic brushing, brush bristle hardness, brushing time and frequency, and abrasive dental products. Clinically, they can be observed as grooves in the tooth structure[23,26].

Abfraction is wear caused by traumatic occlusal force; this stress is more concentrated in the cervical third

of the tooth, causing enamel microfractures and prism rupture. The causes of this destruction are parafunctional habits, temporomandibular joint disorders, poor distribution of occlusal force and enamel fragility over the years, justifying the incidence in older people[10,27].

Available restorative materials for restorations of non-carious cervical lesions:

Glass ionomer cement (GIC)

Formed by glassy powder and polycarboxylic acid liquid, conventional GICs are fluoridated restorative materials, popularly used in pediatric dentistry and preventive treatments such as sealing of pits and fissures. Their potential to release/recharge fluoride to the oral environment favors tooth remineralization and hinders the development of caries. The concentration released by fluoride is greatest in the first 48 hours, after which the release is lower, continuous, and prolonged[28].

They present ionic adhesiveness to calcified substrates and biocompatibility. In restorations that require mechanical and aesthetic properties, GICs do not present satisfactory results due to poor color stability, handling difficulties related to their viscosity, solubility, and retention failures[19,29].

Resin-modified glass ionomer cement (RGIC)

Developed in 1970 by Wilson and Kent30, the conventional glass ionomer cement underwent modifications to improve its physical and mechanical properties. Thus, resin modified glass ionomer cements (RGIC) were developed, containing resin monomers and photosensitive components. They show better solubility, wear resistance and reduced setting time compared to conventional GIC. However, their color stability is poor and they do not have good wear resistance[20,28].

Regular resin composite

Regular resin composites (RC) are often used in restorative treatments of NCCLs, as they have excellent esthetic results and good resistance to wear. However, components present in the resins exhibit polymerization shrinkage, and this generates stress at the adhesive tooth-restoration interface. To minimize the effects of this contraction, insertion of the resin composite into the cavity should be incremental[17].

The high modulus of elasticity present in RC decreases the flexibility of the restoration during occlusal loading, to which teeth are subjected during function. The failure of NCCL restorations of this hybrid material may be associated with its hardness[31].

Flow resin composite

Flow resins composite are syringe-shaped, designed to be injected directly into the area of interest, facilitating the insertion procedure. Their low viscosity allows the material to flow throughout the cavity, ensuring good marginal adaptation[32].

Their properties allow minimally invasive restorations, sealing of pits and fissures, lining of cavities, and have a low rate of adhesive failure in regions of stress concentration, such as in restorations of non-carious cervical lesions. However, they have poor mechanical properties[33].

Fluid composites differ from regular composites in that they have low viscosity. Some materials achieve this fluidity by reducing the content of filler particles in their composition, while others rely on the increase of diluent monomers in their matrix, which explains the variations in flow of materials sold in the dental market[34,35].

The modulus of elasticity of flowable resin composites can be up to 30% lower when compared to regular RC, ensuring that this restorative material has good flexibility, thus mitigating the effects of polymerization shrinkage stress at the tooth-restoration interface and the effects of occlusal forces[32,26].

Bioactive resin composite (GIOMER)

These are restorative materials that present the combination of the properties of RC and GIC, developed by the company Shofu INC. (Kyoto, Japan) in the early 2000's, Giomer is classified as an intelligent material, capable of releasing and recharging fluoride present in the oral environment. This phenomenon occurs by chemical reactions, and its composition counts on S-PRG (Surface Pre-Reacted Glass Ionomer) particles that absorb the fluoride present in toothpastes and mouthwashes and release it to the oral environment when the fluoride ion levels are low. In case of interaction with oral fluids during the handling of the restorative material, the surface of the S-PRG particle protects the glass core from the negative effects that moisture can have on the restorative material[37].

The S-PRG technology, in addition to releasing fluoride ions, provides sodium, silicate, aluminum, borate and strontium ions to the environment. These ions have the biological functions of inhibiting plaque formation, preventing Streptococcus mutans from adhering to the enamel surface and helping to maintain a balanced oral pH. Strontium and fluoride bind to hydroxyapatite crystals, favoring the formation of apatite and fluoroapatite[38].

Restorative materials containing Giomer technology are easy-to-handle materials; their optical properties resemble natural teeth, having the "chameleon" effect of

incorporating the color of the surrounding substrate, but if necessary, specific shades can be added to mimic the dental element[39].

DISCUSSION

It is estimated that about 25% of the population has non-carious cervical lesions[29]. The cervical area of the tooth is the most vulnerable to wear because the enamel is less thick and has less protein and mineral content, and the dentin is less resistant[4,21].

Factors such as abfraction, erosion and abrasion cause these cervical lesions, and their evolution is slow and irreversible. It causes the disappearance of the cemento-enamel junction, and may cause dentin exposure to the oral environment, hypersensitivity, and in more advanced lesions, pulp necrosis. Dentin exposure alters the dentin surface, making it sclerotic; this fact occurs by obliteration of the dentinal tubules, which promote sealing to protect the pulp canal[40,41].

The NCCL affect people of all ages, with prevalence in older people because their teeth have been exposed for longer to chemical and physical factors, behavioral habits and diet[3]. Their incidence is in upper bicuspid teeth and the buccal surface. The lesions in the initial phase may present as white spots, shallow disc-shaped surface, but may evolve to deep cavities, usually wedge-shaped[4,27].

Erosion wear is caused by gastric acids, caused by eating disorders such as bulimia, anorexia, regurgitation and refluxes, and by acids present in foods and beverages such as soft drinks, juices, citrus fruits and dried fruits, tomato sauce, wines, isotonic drinks, teas, vinegars and vitamin C drinks[3,24]. Bartlett et al. [6] in clinical studies with over 3,000 adults in 7 European countries, correlated the developments of NCCLs to beverages with a high concentration of carbohydrates present that stimulate acid production.

Abrasion is generated by frequent contact or applied force of the teeth to objects or substances[5,9]. In 66% of the cases it is due to the frequency and excessive force in tooth brushing, hardness of the toothbrush filaments and abrasive toothpastes present in toothpastes and hard foods[10]. The energy generated is concentrated in the cervical region of the teeth, causing groove-like lesions[19].

Abfraction comes from traumatic occlusal compressive, shear and traction forces. It causes microfractures in the cervical third of the enamel, dentin elasticity and reduction of the HUNTER-SCHREGER band thickness. With the vulnerability of the cervical region, acidic and abrasive agents become adjuvants for lesion progression[2]. Grippo et al.[9] described that wear may be caused by masticatory cycles, deleterious habits such as bruxism, poor distribution of occlusal forces, tooth anatomy and presence and size of restorations. This lesion has a wedge shape and defined limits.

It is difficult to point a single etiological factor that causes the NCCL, because it is multifactorial and has co-factors that can aid in degradation, such as saliva pH and integrity of hard and soft tissues around the tooth[10,23]. Researchers believe that the association of etiologic factors are the cause of the development of the lesion[6,7].

NCCLs may present different signs and symptoms among people; however, treatments follow the particularity of each individual[20]. In some cases, restorative treatment is indicated, and when there is root exposure periodontal treatment is essential[42].

The target of many studies by researchers around the world, glass ionomer cements and resin composites have undergone improvements in their properties. Although conventional GICs and RGICs have been applied in NCCL restorations, their limitations are mechanical strength, color stability, and retention[28].

In a three-year randomized clinical study, Celik, et al.[31] compared lesions restored with CIVRM and RC. The results showed that restorations with CIVRM had inferior clinical performance to those performed with RC, the main problems were loss of retention and reduced surface gloss.

Resin composites are the restorative materials of preference by clinicians, especially in restorations of anterior teeth and class V lesions[35], because they show excellent results in mechanical and optical resistance (fluorescence and opacity), various shades of colors and chemical compatibility to natural teeth[4]. Ferracane[35] describes clinical studies from 10 to 20 years with satisfactory results in resin composites restorations, with failure rates of 2% per year.

Shaalan et al.[43] reports that restorations in NCCL performed with flowable and conventional composites had good results, showing no significant differences, but in posterior teeth the flowable RC showed mechanical failure.

In the early 2000s, Giomers are inserted in the dental market by the company Shofu INC. (Kyoto,Japan). This RC classified as an intelligent material, has in its composition the association CIV, presenting mechanical properties, biocompatibility, fluoride release/recharge and color shades. Moreover, it has particles with S-PRG technology, which provides the oral environment with ions of sodium, silicate, aluminum, borate and strontium, with biological functions to inhibit plaque formation and help balance oral pH[37,39].

Rusnac et al.[44] describe in their studies that Giomers have the advantages of mechanical strength and aesthetic finishes of RCs and

anticariogenic properties of GICs. Gordan et al.[38] report longevity studies with Giomer demonstrating excellent strength, aesthetic and retention results. According to Pecie et al.[45] Giomers show significantly better surface finish and aesthetic quality when compared to conventional GICs and GICMRs.

Garoushi et al.[46] subjected the fluoride restorative materials, Dyract, CompGlass, BEAUTIFIL II, ACTIVARestora and GC Fuji II LC to wear testing with 15,000 mastication cycles using a dual-axis simulator. The Beautifil II material (Shofu INC.) exhibited high fracture toughness values and showed the best flexural strength result of 145 MPa under dry and wet conditions. According to the author, the mechanical and physical property of Giomer, is due to the S-PRG technology.

Similarly, Burtea et al.[37] performed laboratory tests to evaluate flexural strength of Giomer Beautifil II (Shofu INC.) and the recorded value was 115.7 MPa, surpassing values of the ISO 4049/2000 standard that establishes 80 MPa.

Gordan et al.[38] conducted clinical studies evaluating the behavior of restorations made with Giomer resin composites combined with a self-conditioning primer. The patients ranged in age from 21 to 62 years old. After 13 years of follow-up, they concluded that Giomers are excellent restorative materials in NCCL treatments, mainly because it is an area of difficult retention, marginal adaptation and stress concentration[44].

One of the main failures of restorations is microleakage at the restoration-tooth interface, causing postoperative sensitivity, detachment, and development of secondary caries. Treatment success depends on the effectiveness of the adhesive system used to bond the resin-substrate interface[14]. The 37% phosphoric acid is an adjuvant for this adhesion, according to Kwansirikul et al.[47] in sclerotic dentin, acid etching should follow the standard protocol, increasing the time of the acid action to sclerotic dentin does not change the effectiveness of this procedure.

Van Meerbeek et al.[48] performed clinical performance evaluations of 13 bonding agents on NCCLs with a 13-year follow-up. Only five adhesives showed a retention rate greater than 50%. The 3-step adhesive Clearfil Liner Bond (Kuraray) with 74% retention; the glass ionomer modified resin Vitremer (3M ESPE) with 64%; 3-step Syntac Classic (Ivoclar-Vivadent) with 64%; 3-step OptiBond Dual Cure (Kerr) with 59% and the 2-step adhesive ART Bond (Coltène, Altstätten, Switzerland) with 59%.

In a follow-up also of 13 years, Peumans et al.[49] subjected two adhesive systems considered the gold standard to retention tests. The adhesive Clearfil SE Bond (Kuraray) showed a 96% rate and the Optibond FL (Kerr,Orange, CA, USA) the rescored rate was 94%.

It is believed that as important as the choice of restorative material and bonding system, are the care and methods in the light-curing process[33,45].

Research conducted by Leprince et al.[50] reported that factors may interfere in the light-curing stage such as physical-mechanical properties of the restorative material, its viscosity, the thickness inserted in the preparation, color shades (darker shades require a longer time to set), the depth of the cavity, light intensity, time, temperature, positioning and distance between the tip of the light-curing device and the resin composite.

According to Ferracane[17] the main failures caused by the stress of polymerization contraction are marginal infiltrations and displacement of the restoration, and this stress can be transferred to the tooth structure and cause cracks and enamel fractures. Van Dijken[51] complements this and describes that these failures can cause marginal staining, development of secondary caries, and postoperative hypersensitivity.

The risks of polymerization shrinkage can be reduced with incremental RC techniques to the cavity preparation. This increment alternated with the polymerization light reduces the speed of volumetric shrinkage[17].

In addition to the direct technique of incrementing restorative materials in NCCL, the semi-direct technique can be performed. Published in 2019, Caneppele et al.[52] performed a two-year randomized clinical evaluation of resin composite with direct and semi-direct technique in NCCL restorations. The results showed greater failures in the semi-direct technique, for the authors this technique was not shown to be advantageous, for presenting greater clinical preparation time compared to the direct technique and for the difficulty of working with a small fragment of extra oral restoration, requiring the professional skill and knowledge.

In summary, the NCCL should receive specific attention and care, restorative materials return the lost structure, aesthetics and occlusal function of the affected elements[53]. As we know, each step performed correctly results in the success and longevity of treatment, such as isolation of the operative field, choice of adhesive systems, acid etching, techniques for incrementing RC into the cavity, and light-curing method[14].

Some researchers advocate the idea of performing a grinding treatment on the sclerotic surface in order to improve the retention rate of the restoration[40]. Based on this concept, Correa et al.[54] after results of a systemic meta-analysis review, describe that the characteristics of NCCLs do not interfere with the success of the restoration. Soares and

Grippo[55] performed 3D finite element analysis of stress concentration in NCCLs of different morphologies with RC restorations. In summary, the authors describe that these internal roundings cause an increase in lesion size and cause pulpal irritation. However, this intentional wear disrupts the philosophy of minimally invasive dentistry.

CONCLUSION

With the limitations of this study, we can conclude that:

1. NCCLs are multifactorial lesions that require the professional knowledge to conduct the treatment effectively.
2. The Giomer, Beautifil II (Shofu INC.) showed the best results in fracture resistance, flexural strength and excellent aesthetics, it has anticariogenic potential, anti-plaque bacteria and contributes to the oral pH balance.
3. The bonding agents are essential for the retention of the restoration and its longevity, the Clearfil SE Bond adhesive system (Kuraray) showed the highest retention rate among its competitors.
4. It is essential that the clinician knows the light-curing methods, the risks inherent to failure and insertion techniques to reduce polymerization shrinkage.

CONFLICT OF INTEREST

The authors certify that this research is free of conflicts of interest.

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