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Noncarious cervical lesions: from etiology to treatment

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Abstract

Objective: this article aims to review the literature on noncarious cervical lesions, from etiology to treatment, considering it a multifactorial disease. **Material and Methods:** This was a literature review on noncarious cervical lesions, using the PubMed database and the Google Scholar search tool in 2017 and 2018. This research also employed a textbook on the subject as a basis. **Results:** the literature cited in the article showed that although there is no consensus, mechanical stress and biocorrosion seem to play a major role in the formation and progression of these lesions. **Conclusion:** further studies with standardized methodologies are needed to help explain the etiology of noncarious cervical lesions.

Keywords: Tooth wear; Tooth cervix; Toothbrushing; Tooth erosion; Dental disease.

Introduction

For a long time, the origin of noncarious cervical lesions (NCCLs) was attributed exclusively to physical and chemical factors (extrinsic and intrinsic).[1,2] With the introduction of the concept of dental structure bending proposed by Lee and Eakle[1] in 1984, greater importance began to be attributed to the mechanical factor in the onset of this type of injury. This influence was evidenced by laboratory tests and analysis of finite elements of teeth submitted to axial and non-axial forces.[3-6]

Currently, the most accepted theory is that noncarious cervical lesions have a multifactorial etiology, involving mechanical (premature contacts and/or parafunction, generating oblique forces and/or dental structure fatigue, followed by tooth fracture), chemical (biocorrosion) and physical (abrasion by toothbrushing) factors.[7] However, the contribution of each of these factors to the formation of noncarious cervical lesions still has to be elucidated.

Regarding therapeutics, there are many treatment options in the literature, which vary according to the understanding of each author on the subject. However, there are no well-defined protocols, since the etiology of this type of lesion remains uncertain. In this context, the objective of this work was to review the literature on factors involved in the formation of noncarious cervical lesions, and to discuss treatment options based on the multifactorial understanding of NCCLs.

Material and Methods

This review was based on a survey of articles published between 1975 and 2017. Data were collected from the PubMed database and the Google Scholar search tool, in the years 2017 and 2018, using the term "noncarious cervical lesions." Articles in Portuguese and English that addressed topics such as the prevalence, diagnosis, etiology, treatment and prevention of noncarious cervical lesions were selected. Theses and dissertations were not considered. This work also had the support of a textbook on the subject.

Literature Review

Definition and Prevalence

According to the literature, noncarious cervical lesions can be defined as the loss of dental structure in the region of the cementoenamel junction (CEJ), also known as tooth cervix.[8-11] Borcic *et al.*[10] adds to this definition the absence of caries as an etiological factor, and that these lesions are more frequent in the vestibular face of the cervical region, which might be explained by lower saliva exposure in the vestibular faces when compared to the lingual and palatine faces and, consequently, a greater biocorrosive effect in these regions.[12]

Physical (attrition and abrasion), chemical (acidic diets, reflux, among others), and mechanical (premature contact, bruxism, group function, lack of appropriate anterior guidance, etc.) factors have been associated with the appearance of noncarious cervical lesions, as shown in Figure 1. However, there is no scientific consensus on the true etiology of

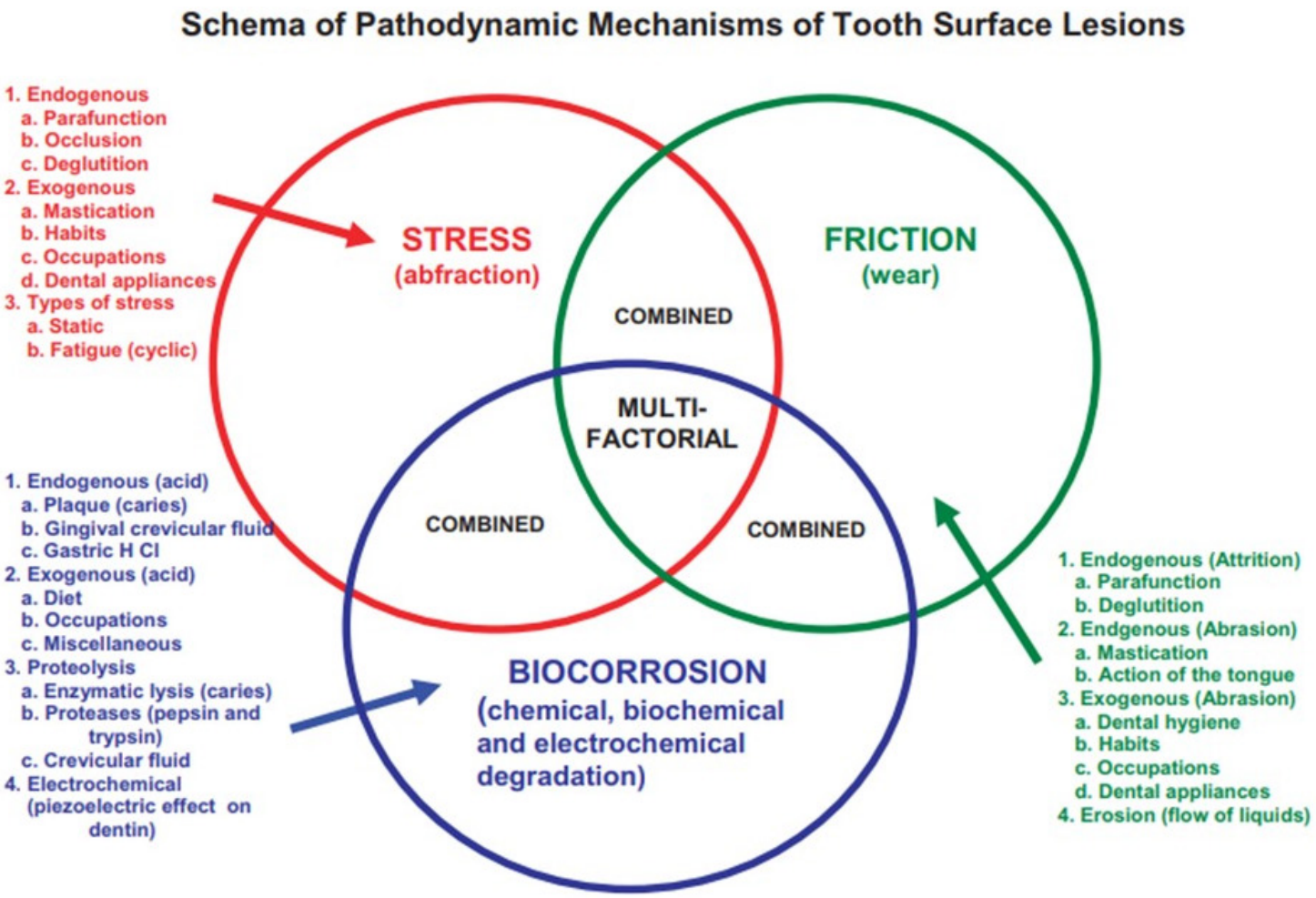

Figure 1. Schematic of pathodynamic mechanisms of tooth surface lesions (schematic of pathodynamic mechanisms of tooth surfaces[7])

these lesions.

This type of injury has become a common challenge in the clinician's routine. Studies have concluded that 5-85% of the population is affected by noncarious cervical lesions, and that premolars are the most affected teeth.[13] Incidence and severity of the lesions increase with age, and prevalence is higher among the elderly.[9,14]

Morphology and Types of Wear

Clinically, NCCLs present themselves in distinct ways: some have more defined borders and are wedge or V-shaped,[4,12,15] others have softer angles and are rounded, or U-shaped,[4,12,16,17] and a third type, the mixed one, is characterized by defined margins and a rounded bottom.[12] Lee and Eakle[1] assumed that the lesion would typically be wedge-shaped and that its size would be directly related to the magnitude and frequency of non-axial forces. Other formats would originate from to the combination of local factors such as abrasion and corrosion.

In contrast, Litonjua *et al*.[18] believed that the configuration of the lesion varied according to the toothbrushing technique, that wedge injuries were caused by horizontal toothbrushing, and that lesions with softer angles were caused by vertical toothbrushing.

Other authors have suggested that these distinct presentations are due to the predominant factor involved in their formation: wedge-shaped lesions would be associated with abrasive factors, and U-shaped lesions with biocorrosion.[12,16,19,20]

In order to distinguish the types of damage to dental structures in a more didactic manner, Grippo[21] suggested dividing the different types of tooth structure wear, as shown in Table 1.

Table 1. Different types of tooth structure wear (Adapted from Grippo[21])

Different types of wear	
Attrition	Wear resulting from tooth-to-tooth contact from normal mastication and/or parafunctional habits. It is more frequent in the incisal edges of the anterior teeth and in the occlusal faces of the posterior teeth. This type of wear can appear in the interproximals resulting from friction between one tooth and another when they are in function.
Abrasion	Pathological wear of dental structure resulting from abrasive processes, such as toothbrushing. Habits like nail biting and pipe smoking can contribute to this type of wear.
Erosion	Loss of dental structure due to acidic dissolution, either of intrinsic origin (reflux, bulimia) and/or extrinsic (consumption of acidic foods). It has been suggested that the term biocorrosion would be more appropriate to refer to chemical actions that result in loss of tooth structure[7].
Abfraction	Pathological loss of dental structure caused by biomechanical loads that cause the tooth to bend and subsequently lose tissue.

Etiology

In 1984, William Lee and Stephan Eakle[1] elaborated the theory of abfraction, proposing that the tooth would bend due to lateral forces, causing deformations that, over time, would lead the tissue to fatigue. This fatigue would allow the hydroxyapatite crystals of the tooth to break, creating microfissures in its structure; these microfissures would then be infiltrated by small molecules of water and other ions, preventing the remineralization of the region in contact with saliva. Once the structure became fragile, it would be more susceptible to the action of chemical and physical agents in the buccal environment.

After this theory, greater importance began to be attributed to the occlusal factor in the formation of cervical lesions, and much research has been done to try to prove the existence of an etiological mechanism. However, with the lack of methodological standardization and the biased character of many studies, robust scientific evidence regarding the origin of noncarious cervical lesions is still needed.[22,23]

In a literature review discussing the effects of the interaction between attrition, abrasion and erosion on tooth wear, Addy and Shellis[24] assessed that the abrasion/erosion interaction was the most damaging. They considered it the main process acting on tooth wear; in this sense, occlusal factors would be secondary in the formation of cervical lesions. They further emphasized that there was no clinical evidence demonstrating the theory of abfraction in practice. Similarly, Lintonjua *et al.*[18] suggested that oblique forces would not influence the development of noncarious cervical lesions.

In 2003, the Academy of Restorative Dentistry developed a NCCL diagnostic, treatment and prevention guide; the guide suggested that the etiology of NCCLs was multifactorial and did not result from an isolated factor.[25] According to Nascimento *et al.*,[16] chemical, biological and behavioral factors are initiators of noncarious cervical lesions, and depending on the interaction between these factors, such defects could present themselves clinically in different ways.

Based on the theory of dental bending, Antonelli *et al.*[26] performed a case control study attempting to associate the presence of cervical lesions with the type of excursive guidance performed by the patients (canine x group function), under the principle that group function would exert non-axial forces on the posterior teeth. In their study, patients served as their own controls, performing canine function on one side and group function on the other. It was observed that there was a higher prevalence of these lesions on the group function side. The authors concluded that occlusion is an important factor in the formation of these lesions.

Studies such as the one by Palomino *et al.*[27] and Smith *et al.*[28] showed the same association between abfraction lesions and group function, supporting the findings by Antonelli. Furthermore, Sawlani *et al.*[29] suggested that this factor could contribute significantly to the progression of NCCLs, and Pegoraro *et al.*[30] found strong associations between these lesions and wear facets, thus showing, according to the author, the role of occlusal forces in their formation.

In a laboratory trial, which according to the author was the first *in vitro* production of noncarious cervical lesions, Whitehead *et al.*[31] immersed solid teeth in an aqueous solution of sulfuric acid, with part of the sample being subjected to axial forces. Although a small part of the sample had tissue loss similar to cervical lesions, the authors concluded that stress and corrosion could contribute to the etiology and that the occlusal factor seemed to play a major role in the formation and progression of these lesions. Takehara *et al.*,[32] however, suggested that the lesions were associated with toothbrushing accompanied by exacerbated occlusal contact.

Treatment

As in their etiology, the suggested therapies for cervical lesions are diverse. In order to treat an injury, it is imperative that its cause is identified and removed. Thus, the procedures indicated for the treatment of NCCLs vary greatly

among professionals, according to the understanding of each professional regarding their etiology.

Years after formulating the theory of dental structure bending, Lee and Eakle[2] reviewed the literature on stress-induced lesions. They suggested that orthodontic treatment, reinstatement of anterior guidance and/or occlusal adjustments could rebalance the patient's occlusion and reduce or eliminate the lateral forces causing the lesions.

In doing so, the dentist would resort to restorative procedures, using materials able to resist the factors that caused the injury. In line with this concept, Ichim *et al.*[33] suggested that, in restoring noncarious cervical lesions, the dentist should opt for flexible materials able to withstand deformations of the dental structure.

Nanoparticulate composite resins, associated with the selective enamel conditioning technique and with two-step self-etch adhesives, are a good restorative treatment alternative for Class V lesions, since the self-etching systems present better performance in dentin, while the composite resin's nanoparticulate characteristic may provide enough polishing and mechanical resistance for good treatment longevity.[12]

Restorative procedures can employ direct, semi-indirect or indirect techniques. When performed using the direct technique (Figure 2), restorations should be made in increments, in order to decrease the tension of contraction inherent in composite resins. Regardless of the chosen technique, it must provide a good marginal adaptation and satisfactory level of polishing to the restored region.[12]

Figure 2. Noncarious cervical lesions restored by the direct technique. (A) Patient with cervical lesions on teeth 21 and 23, frontal view; (B) Cervical lesions on teeth 21 and 23; (C) Teeth 21 and 23 restored with composite resin; (D) Front view of the smile after restorative treatment

In the indirect technique, ceramic fragments can be employed—especially in cases associated with gingival recession, when grafting is required—since their surface smoothness and polishing are superior to the composite resin. Once restoration is completed, in addition to better dissipation of forces along the tooth, the progression of the lesions becomes more difficult, due to the protection provided to dentin by the restorative material. Dentin is more susceptible to the chemical and physical conditions of the oral medium.[12]

Another benefit of restoring noncarious cervical lesions is that the adhesive can also act as an obliterating agent of the dentinal tubules, thus solving problems of cervical dentin hypersensitivity, which are frequently associated with NCCLs.[12]

According to Grippo,[34] restorative procedures are indicated in cases of risk of dental fracture or pulp exposure, hypersensitivity, aesthetic problems, plaque retention areas, among others. Restorations are also indicated for cases where it is necessary to change the shape of the tooth for prosthesis retention.[9]

According to Nascimento *et al.*,[16] therapeutic possibilities include monitoring of the lesions, non-invasive procedures such as application of fluoride, adhesive, desensitizers and fluoride varnishes to reduce hypersensitivity; and more complex procedures such as restorative and periodontal approaches, in which the lesions are restored and later covered by means of regenerative surgeries. According to these authors, there is no scientific evidence supporting effects of occlusal adjustment on the progression of noncarious cervical lesions.

Whatever treatment is chosen, the therapeutic approach must be consistent with the diagnosis proposed by the dentist and with the needs and wishes of the patients.[8,16]

Discussion

When reviewing the literature, it is noticeable that the issue of noncarious cervical lesions remains poorly understood. This of course leads to different and even controversial treatment proposals.[8,35] In addition, there are misuses of terminology when attempting to classify a cervical lesion,[36] since clinically it is very difficult to ascertain its main originating factor. Regardless of these difficulties, it is important to remember that, whatever the predominant factor, physical, chemical and mechanical agents can act simultaneously in the formation of these lesions in the buccal environment,[1,21,25,26] although the specific contribution of each factor has not yet been elucidated.

Toothbrushing

Much is discussed about the role of each factor in the etiological process of noncarious cervical lesions. Toothbrushing, for example, had its relevance questioned by Bartlett and Shah.[37] After reviewing the literature, they concluded that there was little evidence to support cervical wear being caused merely by abrasion.

This statement is corroborated by Svinnseth *et al.*[38] and Joiner *et al.*[39] who concluded that wear caused by dentifrices was clinically insignificant, and by Volpe *et al.*[40] who found

no correlation between the progression of NCCLs and the abrasiveness of two types of dentifrices.

In a field study aiming to evaluate the influence of toothbrushing on cervical lesions, Faye *et al.*[41] examined patients with leprosy, residents of rural villages in Senegal who did not have the cultural habit of brushing their teeth. Lesions were found in 47% of the patients, which led the authors to conclude that abrasion was not an active factor in the formation of those lesions. Although the authors disregarded the abrasive factor, they emphasized the importance of the corrosive effect in the etiological process, attributing this chemical effect to the consumption of acidic beverages.

McEvoy *et al.*[42] and Ritter *et al.*[43] found NCCLs in the dentitions of prehistoric peoples, placing the role of toothbrushing on the etiology of these lesions under suspicion.

Biocorrosion

The role of the chemical factor was demonstrated in a series of papers. In addition to the study by Faye *et al.*,[41] laboratory tests corroborate this factor's relevance in the formation of cervical lesions.[7,31,44] However, these studies have shown the modulating effect of the chemical factor in relation to the progression of the lesion—which can be accelerated in environments with a more acidic pH when compared to more alkaline media—and not as an initiating factor of the lesions.

When analyzing the studies, it might be suggested that the chemical factor alone cannot produce defects similar to the cervical lesions found in the clinical setting, although the mineral content and thickness of enamel are reduced in the region near the CEJ.[12]

Another interesting observation is that the solutions in which the teeth are immersed produce a dissolution of the tissue, which extends beyond the cervical area, showing a corrosive effect on the tooth as a whole, regardless of which area was exposed to the acid.[31,44]

Mechanical Stress

In a study by Palamara *et al.*,[44] scanning electron microscopy allowed the authors to observe fractures perpendicular to the CEJ and approximately parallel to the long axis of the tooth, in the middle and cervical thirds, in one of five teeth submitted to non-axial forces and immersed in distilled water. This finding suggests that mechanical factors can cause tissue loss isolated in the cervical region, and thus can be considered an initiating factor of noncarious cervical lesions.

Studies that analyzed their samples by means of finite elements evidenced that the dental structure does in fact bend against axial and non-axial forces, with the resulting oblique forces in thesis responsible for generating a greater concentration of stress in the cervical region,[5,6,15,45-47] which would explain the observed loss of tissue in the cervical third.

However, the aspect of the fracture and the loss of enamel evidenced by microscopy suggest that to produce lesions similar to those found clinically a chemical agent may be required.

In one of his papers investigating the role of the occlusal factor in the etiology of NCCLs, Antonelli *et al.*[14] reviewed the literature and presented articles showing a relationship between occlusal factors, such as bruxism and group function, and cervical lesions, which according to the authors are associated with NCCLs.

For the author, the high prevalence among the elderly corroborates the importance of the occlusal factor in the etiology of these lesions, since the absence of multiple teeth is common in the older population, which results in a smaller number of elements to dissipate the occlusal load. Factors such as aging and xerostomia have also been taken into account and may be associated with the high incidence of lesions in the elderly.

Treatment

It has already been demonstrated, by means of finite elements, that in the presence of a cervical lesion the dental structure's behavior changes, generating a greater concentration of stress in the cervical region. This behavior is modulated by both the size and configuration of the cavity.[49]

Such findings reinforce the need for restorative intervention to reestablish a more adequate mechanical behavior of teeth affected by NCCLs, and also to protect the exposed dentin from the action of chemical and physical factors, as previously mentioned.

Prior to the restorative procedure, it is necessary for the etiological factors to be controlled or, if possible, removed. To this end, there are alternatives to rebalance occlusal load dissipation and to remove deleterious lateral forces on the teeth, such as occlusal adjustments; restorative procedures in anterior guidance or only in canine teeth, with the aim of reestablishing canine and protrusive guidance, and/or orthodontic treatments, the latter being more indicated when larger corrections are necessary, as in cases of rotated or unfavorably tilted teeth.

Control of diet, and of gastric and psychological problems, as in cases of bulimic patients, is also a valid tool to prevent or reduce the progression of noncarious cervical lesions.

It is important to emphasize that the basis for all treatment is an accurate diagnosis, able to put into evidence the factors involved in each case. This treatment must be performed in the least invasive way possible, adjusting to the reality and needs of the patient. Therefore, restorative and orthodontic treatments are generally preferable to occlusal adjustments, which involve the removal of healthy tissue to allow for more favorable occlusion conditions.

Conclusion

Based on the literature cited in this article, it can be concluded that the lack of standardized studies is a great obstacle to the generation of reliable scientific evidence able to better explain the etiology of noncarious cervical lesions. Furthermore, mechanical stress and biocorrosion seem to play an important role in the etiological process and progression of NCCLs.

Thus, a correct and detailed anamnesis is an important instrument to draw up an effective treatment plan, based on a multidisciplinary diagnosis, evaluating, controlling and whenever possible removing the probable etiological factors. Orthodontic procedures, occlusal adjustments, and dietary control are valid approaches in the treatment of noncarious cervical lesions, providing longevity to the treatments and satisfying the patient's wishes.

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