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Research Article

The degree of involvement of etiological factors in different types of non-carious lesions

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Abstract. Objective: The etiopathology of non-carious cervical lesions is multifactorial and still not fully understood. Non-carious cervical lesions are defined as loss of dental hard tissue by a chemical or mechanical process that does not involve bacteria. The purpose of this clinical study was to determine the correlation of the etiological factors involved in the progression of non-carious lesions. Materials and methods: The study group comprised 60 patients, aged 25-70 years, presenting at least two non-carious lesions. Dental and occlusal examinations were performed in the patients included in the study. Dental examination was conducted to highlight the location and shape of the lesions. A questionnaire addressing dietary habits - consumption of acidic drinks, dental history, oral hygiene practices was distributed. Results: In the examined teeth, non-carious lesions were located on the vestibular surface in the cervical third of the crown. Associations with oral hygiene and consumption of acidic drinks were revealed. A relationship between lateral excursive contact of teeth and formation of cervical lesions was established, evidencing a correlation between occlusal and cervical pathology. Conclusions: The frequency of non-carious lesions increases with age, through repetitiveness of the predominant etiological factor. Understanding the risk factors of erosion, abrasion and abfraction is important for the diagnostic and treatment protocol of patients.

Key Words: erosion, abfraction, abrasion, non-carious lesion.

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Introduction

In the context of population aging and a more prolonged maintenance of dental health, the problem of tooth wear and non-carious lesions becomes increasingly important for dental practitioners. The term non-carious cervical lesion defines dental tissue loss of non-bacterial etiology in the cervical area (Grippo et al 2012). The etiology of non-carious cervical lesions (erosion, abrasion and abfraction) is complex and multifactorial, involving specific factors for the initiation and progression of each type of non-carious lesion, as well as common factors (Michael et al 2010).

Erosion refers to dental hard tissue loss by a chemical process, without a bacterial cause. Tooth erosion can occur through the exogenous chemical and endogenous biochemical action of acids, through the biochemical action of enzymes and piezoelectric effects that act on the dentin matrix, which is mostly composed of collagen. Thus, acid degradation of internal cause (gastroesophageal reflux) is a possible mechanism of induction of these lesions (Eccles 1982). Bulimia is another cause of chemical attack on the teeth, the lesions being situated on the vestibular surfaces of the maxillary teeth.

Abrasion was first described in 1894 by Zsigmondy as an angular defect and later, in 1907, Miller defined it as tooth structure wear, concluding that hard tooth brushing and the effect of highly abrasive dentifrices are etiological factors in the induction of non-carious lesions (Miller et al 2003). Abrasion is due to interaction between teeth and exogenous objects and substances, such as toothpicks, dental floss, a highly abrasive toothpaste or toothbrush - especially when these have hard bristles and too much pressure is applied during brushing (Kaidonis, 2008).

The clinical appearance of non-carious lesions can vary depending on the type and severity of the etiological factors involved (Bartlett & Shah, 2006). Of all possible etiological factors for non-carious lesions, occlusal stress forces have received maximum attention over the years. Occlusal loading has a fundamental role in the initiation of lesions. In 1991, Grippo coined the term abfraction as a new classification of cervical lesions caused by biomechanical loading forces, to distinguish it from erosion and abrasion (Grippo 1991). The theory of abfraction sustains that tooth flexure in the cervical area is caused by compressive occlusal forces and tensile stress, resulting in microfractures of the hydroxyapatite crystal of enamel and dentin, with further fatigue and deformation of the tooth structure (Lee et al 2002; Rees 2006; Silva et al 2013).

Nowadays, it is generally incorrect to designate only one mechanism as the cause of any type of non-carious lesions. Instead, current evidence supports a multifactorial etiology for all non-carious lesions, with patient factors being responsible for the various degrees of tooth loss (Levitch et al 1994; Mayhew et al 1998).

Figure 1 shows the scheme of pathodynamic mechanisms responsible for initiation and perpetuation of non-carious lesions, as proposed by Grippo et al. (2012).

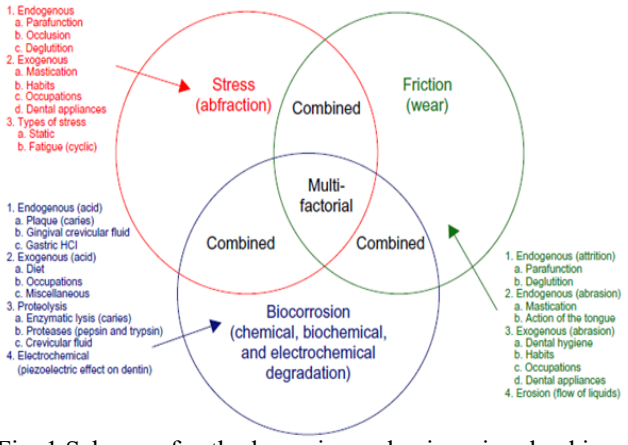

Fig. 1 Scheme of pathodynamic mechanisms involved in non-carious lesions as proposed by Grippo et al (2012).

The aim of this clinical study was to determine the correlation of the etiological factors involved in the progression of non-carious lesions.

Materials and methods

The study was conducted in accordance with the 1975 Helsinki Declaration, as revised in 2000, and was approved and monitored by the Medical Research Ethics Committee of "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca, under protocol number 38/16.

The study was conducted in 60 patients, aged 25 to 70, sex (1:1 ratio). The patients came into Prosthodontics Clinic for a specialized medical care. They have been diagnosed with cervical non-carious lesions. The subjects were informed about the study methods and procedure and their written informed consent was obtained. The study has been carried over a 4 months period (February 2016-May 2016).

The inclusion criteria were:

1. Patients with at least two non-carious cervical lesions with a minimum depth of 1 mm.
2. The teeth included in the study had antagonists .
3. Test teeth should be in occlusion.
4. Vital teeth, free of periapical pathology, with no clinical or radiological evidence.
5. Subjects with normal salivary function.
6. Subjects in a good health condition and able to tolerate the dental procedure.

The exclusion criteria were:

1. Teeth with mobility.
2. Teeth with non-carious cervical lesions with less than 1 mm depth.
3. Subjects with poor oral hygiene.
4. Subjects in poor health condition.

All the patients who met the study inclusion criteria were registered in a database.

For each patient there was carried a clinical examination and there was filled an initial questionnaire regarding the dietary habits and teeth brushing technique. Dental and occlusal examinations were performed in the patients included in the study. Dental examination was conducted to highlight the location and shape of the lesions. Occlusal examination consisted of detecting premature contacts and dental interference in the teeth with non-carious lesions during the excursion movements of the mandible. Contact recording was performed with Bausch 40 micron articulating paper.

Consumption of acidic foods and tooth brushing habits were evaluated using a original questionnaire consisting of 7 questions. There have been collected information about the teeth brushing technique: the frequency of teeth brushing (once, twice or more than twice /day), the length of teeth brushing (1-2 minutes, 3-5 minutes or more than 5 minutes), the teeth brushing technique involved (vertical/ horizontal movements), the type of toothpaste use (abrasive, less abrasive), the type of the toothbrush used according to the firmness of the bristles (soft/medium/hard). Regarding the usual intake of drinks such as Cola or other acidic drinks and citrus consumption (lemons, oranges), the subjects have acknowledged or declined it.

Statistical analysis was carried out using MedCalc Statistical Software version 16.4.3 (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2016). Data were compared using the chi-square test. A p value <0.05 was considered statistically significant

Results

The analysis of the correlations between the different variables involved in the study was achieved in statistical terms, using the Chi-Square test. The strength values of the test, p, in all the situations researched are presented in table (1-7).

Table 1. Consumption of acidic drinks and citrus

Variable		Abfraction	Abrasion	Erosion	p
Consumption of Cola other acidic drinks	yes	8(17.8%)	-	9(100%)	<0.001
	no	37(82.2%)	6(100%)	-	
Consumption of citrus	yes	6(13.3%)	-	9(100%)	<0.001
	no	39(86.7%)	6(100%)	-	

Table 2. The length of teeth brushing

Variable		Abfraction	Abrasion	Erosion	p
The length of teeth brushing	>5	-	2(33%)	-	<0.001
	1-2	37(82.2%)	-	9(100%)	
	3-5	8(17.8)	4(66%)	-	

Table 3. The teeth brushing technique involved

Variable		Abfraction	Abrasion	Erosion	P
Technique used	horizontal	11(24.4%)	6(100%)	-	<0.001
	vertical	34(75.6%)	-	9(100%)	

Table 4. The type of toothpaste used

Variable		Abfraction	Abrasion	Erosion	p
The type of toothpaste used	abrasive	5(11.1%)	6(100%)	-	<0.001
	less abrasive	40(88.9%)	-	9(100%)	

Table 5. The type of the toothbrush used according to the firmness of the bristles

Variable		Abfraction	Abrasion	Erosion	p
Brush hardness	hard	1(2.2%)	6(100%)	-	<0.001
	medium	34(75.6%)	-	8(88.9%)	
	soft	10(22.2%)	-	1(11.1%)	

Table 6. The frequency of teeth brushing

Variable		Abfraction	Abrasion	Erosion	p
The frequency of brushing	>2	5(11.1%)	6(100%)	-	<0.001
	1	1(2.2%)	-	3(33.3%)	
	2	39(86.7)	-	6(66.7%)	

Table 7. Frequency and percentage of non-carious lesions according to sex

Variable		Abfraction	Abrasion	Erosion	p
Sex	F	22(48.9%)	2(33.3%)	6(66.7%)	0.4
	M	23(51.1%)	4(66.7%)	3(33.3%)	

On the shape of lesions, they were grouped as follows:
A. Concave, wedge-shaped lesions with clearly defined edges and the lesions are deeper than wide, evidenced in 45 patients (75%); in these patients, premature contacts and interferences in eccentric movements were detected.
B. Deep, well-defined abrasive lesions, with sharp edges, irregular surface and sharp angles width being greater than the depth of the lesion, in 6 patients (10%) who performed horizontal tooth brushing with increased force and abrasive toothpaste.
C. Smooth, round, concave lesions, without sharp edges or striations, in 9 patients (15%); the teeth with non-carious lesions showed no premature contacts or interferences, but these patients reported high consumption of acid drinks.


A. Abfraction


B. Abrasion


C. Erosion

Regarding the type of tooth guidance, it was found that non-carious lesions presenting premature contacts and interferences in eccentric movements occurred in the first place in teeth participating in group guidance (50%), followed by lateral interfering teeth participating in canine guidance (31%) and anterior teeth participating in propulsion (19%).
The results demonstrate a close correlation between shape and an acidic diet, the tooth brushing technique, the presence of occlusal discrepancies.

Discussions

The findings can be useful for clarifying the main properties of the different types of dental microwear, and therefore help clinicians to promptly recognize them.
The current study focused on the examination of clinically healthy patients, in order to determine the factors initiating the development of lesions, as well as to characterize the lesions in terms of depth, shape and location. Regarding the etiology of non-carious lesions, the results demonstrate a significant relationship between the presence of premature contacts and the occurrence of abfraction. Also, a correlation was established between occlusal discrepancies existing during excursive mandibular movements, the type of guidance and non-carious lesions.
Spranger demonstrated the effects of lateral occlusal forces using models mounted in a semi-adjustable articulator. He placed piezoelectric transducers at the level of the first lower molars. Real occlusal forces were applied and the application of forces in centric occlusion was reported to induce a 20 µm lateral deformation in the cervical vestibular region. When the forces were applied during lateral movements, deformations between 200-400 µm were observed. It can be concluded that greater deformations generate a higher level of tension in the region corresponding to the cementoenamel junction, leading to the appearance of non-carious cervical lesions (Spranger 1995).
Photoelasticity studies (Asundi & Kishen 2000; Kuroe et al 1999) concluded that oblique forces applied outside the longitudinal axis of the tooth caused torsion stress around the cervical region of the tooth, which might be responsible for the destruction of the crystalline structure of the cervical enamel.
Most of the evidence supporting the association between occlusal stress and cervical lesions comes mainly from finite element analysis and laboratory studies (Antonelli et al 2013). Thus, Borcic et al. published a three-dimensional finite element analysis study, evidencing the development of dental abfraction in an upper premolar. The study confirmed previous findings, reporting a cervical stress level of 82 MPa under the action of oblique forces (Borcic et al 2005).
Concerning erosive cervical lesions, their prevalence was reported to increase with age. The acidity constant pKa contributes to a larger extent to dental tissue erosion than pH. A high pKa value demonstrates that a higher amount of acid than indicated by pH can be ionized, resulting in hydrogen ions. Orange juice causes a more marked chemical degradation than that induced by Cola, although orange juice has a more alkaline pH. Some persons retain the gastric acid content until they can expectorate, which leads to the development of lesions on the vestibular surface in the cervical third of the crown (Eccles 1982). Dietary erosion occurs due to high consumption of foods or drinks containing a variety of acids, such as those from citrus and other fruits, soft drinks and wine. It was reported that erosion can also occur by the frequent use of acidic mouth rinses (Grippo et al 2012).
An abrasion lesion is concave, depending on the exogenous abrasive agent. Following a transversal study, a greater number of cervical lesions were found in subjects who brushed their teeth at least twice a day compared to those who brushed their teeth less frequently (Jaeggi & Lussi 1999). Piotrowski observed that the abrasion rate was influenced by several factors, including the tooth brushing technique, tooth brushing forces,

the hardness of toothbrush bristles and the degree of abrasion of the toothpaste (Piotrowski et al 2001). Brandini examined 58 students who presented lesions and assessed their oral hygiene. Following the study, 53% of the students had cervical lesions. In addition to using a toothbrush with hard bristles, they exerted an increased force during tooth brushing (Brandini et al 2011). Erosion and abrasion act synergistically in vivo, to different extents and at different times.

Conclusions

The study demonstrated a positive relationship between non-carious lesions and an increased number of premature contacts, dietary habits, and the tooth brushing technique. The frequency of non-carious lesions increases with age, through repetitiveness of the predominant etiological factor. Understanding the risk factors of erosion, abrasion and abfraction is important for the diagnostic and treatment protocol of patients.

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