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Diagnosis attitudes and restorative practices of non-carious cervical lesions by a group of Brazilian dentists from the state of Rio de Janeiro

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Abstract

This study aimed to identify diagnosis and restorative practices of non-carious cervical lesions (NCCLs) by a group of Brazilian dentists from the State of Rio de Janeiro. After ethical approval, a questionnaire was sent for a group of dentists registered at the Regional Council of Dentistry of the State of Rio de Janeiro (CRO-RJ, Brazil) and the answers were collected in a period of 15 days. The questionnaire considered training experience and attendance profile, diagnostic attitudes and restorative practices for direct restorations of NCCLs. The data were presented in a descriptive way and Chi-square tests (95% significance) were used to verify possible relations between dentists training/attendance profiles and NCCLs diagnosis/restorative attitudes. Most part of dentists considered the etiology as multifactorial and seek to distinguish the different types of NCCL, but only a minority respond to use auxiliary methods for diagnosis. Cotton-roll is the most used method for moisture control and 51.6% do not use gingival retraction/separation techniques. Two-step total-etch adhesive systems and hybrid/microhybrid composite resins were the most commonly refereed materials for direct restorations. Only 8.3% considered that restorations can last for a period of more than 5 years in clinical service. There was significant relation between remuneration and the type of isolation ($p = 0.038$) and also with gingival retraction/separation techniques ($p = 0.043$). It can be concluded that (a) the majority of the respondents revealed to seek distinguishes among the different types of NCCLs, but only a minority use auxiliary methods to diagnosis; (b) the form of remuneration influence the attitudes regarding the isolation method; (c) the two-step total-etch adhesive systems are the most used to restore NCCLs, (d) and that for the most part of the respondents the restorations of NCCLs made with resin composites do not last for more than 5 years.

Keywords: Abrfraction, Abrasion, Adhesive, Biocorrosion, Composite resin, Non-carious cervical lesions

Introduction

Evidence-based-dentistry (EBD), is defined by the American Dental Association (ADA) as the “approach to oral care that requires the judicious integration of (a) systematic evaluations of clinical evidence, scientifically concerning the condition and medical and dental history of patients; (b) clinical expertise of the dentist; and (c) patient needs and preferences” [1]. Therefore, it is of paramount importance to understand attitudes and practices of dental surgeons who deal with the daily practice [2, 3] in order to improve the quality of services and education. In this scenario, non-carious cervical lesions (NCCLs) deserve special attention.

Non-carious cervical lesions are characterized by the loss of dental structure in the vicinity of the cement-enamel junction (CEJ) by non-carious processes [4]. Although it is not possible to clearly state a numerical prevalence of NCCLs due to variations among the studied populations [6], there seems to have an steady increase of treatments related to NCCLs in the dental practice. Part of this fact can be related with the increase of life expectancy and the maintenance of the natural dentition over the years, with consequent exposure to some of the etiological factors related to NCCLs [4, 5]. Usually, NCCLs mainly affect the buccal face of premolars of adults and elderly [6, 7], and may result from abfraction, abrasion and biocorrosion processes, as well as their interactions [8]. The etiology of NCCLs is controversial in the literature and, due to the complex interaction of several mechanisms, the cause of a certain form of injury is not related to a single mechanism, attributing to NCCLs a multifactorial behavior [5].

Non-carious cervical lesions can occur in different forms. The abfraction is the pathological loss of dental structure through excessive biomechanical forces, that results in flexural stresses and consequent enamel failure at the cervical region of the teeth. It presents a wedge-shape form, with sharp angles both on the slope of the lesion and on the cavosurface edge. On the other hand, abrasion results from pathological tooth wear through repetitive mechanical processes and the lesions take the form of a “V” or a wedge. The cavosurface angle of the lesion is very sharp and the surface of the exposed dentine presents a smooth and shiny appearance. The biocorrosion can occur through exogenous chemical or endogenous biochemical action, such as proteolytic enzymes and by piezoelectric effects. This type of lesion presents a “U” shape, with shallow depth, probable dentin exposure and teeth’s loss of brightness [8, 9]. Regardless of the NCCL type, the restorative approach can be affected by restorative practices and materials choices.

Previous studies have shown disagreement among professionals regarding the causes, the diagnostic methods, the types of treatment, the forms of prevention and the factors associated with NCCLs [4, 10, 11]. A previous pilot study suggests that the dentists do not have a specific approach to correctly perform diagnosis and restorative treatment of NCCLs [12]. In order to establish better protocols and guidelines for regular clinicians, as well as to improve the quality of education of graduate programs and continuing education courses, this study aimed to identify diagnosis and restorative practices of non-carious cervical lesions (NCCLs) by a group of Brazilian dentists from the State of Rio de Janeiro.

Table 1 Training/attendance profile of the interviewed dentists

	n	%
Respondents	337	100
Gender		
Female	219	65
Male	118	35
Years since graduation in dentistry		
< 5 years	48	14.2
5–10 years	69	20.5
11–15 years	35	10.4
16–20 years	46	13.6
21 or more years	139	41.2
Predominant form of remuneration		
Private health insurance	75	22.3
Private practice	185	54.9
Public service attendance	77	22.8

Table 2 Attitudes regarding the diagnosis of NCCLs

	n	%
In front of NCCLs, do you seek to distinguish between abfraction, abrasion and/or biocorrosion lesions?		
No	77	22.8
Yes	260	77.2
Do you use auxiliary methods to diagnose NCCLs?		
No	266	78.9
Yes	71	21.1
Etiology of NCCLs		
Multifactorial	330	97.9
Unifactorial	7	2.1

Materials and methods

This study was approved by the Ethics and Research Committee (Federal Fluminense University; #804.400). The instrument used for data collection was a self-administered questionnaire adapted from Lyttle et al. [10] and Gordan et al. [13], and was based on the concepts of Grippo et al. [8]. The questionnaire was divided into three main groups: (1) training and attendance profile; (2) attitudes for the diagnosis of NCCLs; and (3) attitudes for the direct restorative treatments of NCCLs. The study included 1418 dentists with e-mail address updated in the Regional Council of Dentistry from the State of Rio de Janeiro (CRO-RJ, Brazil) database at the time of the survey. The questionnaire was sent through digital platform (GoogleDocs™), with the informed consent term. The questionnaire was sent and responses received in a period of 15 days (June 2016). All data was kept confidential by the group of researchers. The specific questions are described in Tables 1, 2 and 3.

Data was analyzed and presented as descriptive analysis. Chi-square tests (95% significance) were used to verify possible relations between dentists training/attendance profiles and NCCLs diagnosis/restorative attitudes.

Table 3 Attitudes regarding direct restorations of NCCLs

	n	%
For the restorative treatment of NCCLs, do you use isolation?		
No	22	6.5
Yes, absolute isolation	23	6.8
Yes, relative isolation	292	86.6
For the restorative treatment of NCCLs, do you use gingival retraction/separation techniques?		
No	174	51.6
Yes	163	48.4
By using the retracting wire, do you use a hemostatic substance?		
No	116	34.4
Yes	116	34.4
I never use the retractor wire	105	31.2
Do you use GIC/RMGIC as “liners”?		
Never	86	25.5
Yes, depending on the cavity depth	228	67.7
Yes, always	23	6.8
What type of adhesive system do you use for NCCLs restorations?		
Two-step self-etch (ex: Adper SE Plus, Clearfill SE Bond)	17	5.1
One-step self-etch (ex: Adper Easy One, IBond)	23	6.8
Three-step etch and rinse (ex: Opti-Bond, Scotchbond Multi-purpose)	89	26.4
Two-step etch and rinse (ex: Prime & Bond, Adper Single Bond 2)	208	61.7
Do you use phosphoric acid in enamel when using self-etch adhesives?		
No	23	6.8
Yes	110	32.6
I do not use self-etch adhesive	204	60.5
What composite resin do you use most for NCCLs restorations?		
Hybrid/microhybrid (examples: Charisma, Filtek Z250, Opallis, TPH)	190	56.4
Microparticulate (examples: Durarafill VS, Heliobond, Renamel)	38	11.3
Nanoparticulate (examples: Filtek Supreme, Filtek Z350, Filtek Z350XT)	96	27.5
I do not use composite resin	13	3.9
Based on your knowledge and your clinical experiences, in general, how long does a NCCLs restoration last?		
< 1 year	16	4.7
1 year	37	11
2 years	70	20.8
3 years	59	17.5
3–5 years	127	37.7
6–10 years	26	7.7
11–15 years	2	0.6

Results

Table 1 presents the results regarding training experience and the form of service performed by the dentists. The questionnaire was answered by 337 dentists (23.8% of the total sample), where 65% were female; 41.2% had 21 or more years of training. Private practice was the most frequent form of remuneration (54.9%).

Regarding the diagnostic attitudes (Table 2), it was observed that 77.2% of the respondents revealed to seek distinguishes among abfraction, abrasion and/or biocorrosion lesions; but only 21.1% use auxiliary methods to diagnosis NCCLs. When questioned about the etiology of NCCLs, 97.9% attributed multifactorial lesions.

Considering the restorative treatment attitudes for the direct restorations of NCCLs (Table 3), it was observed that 86.6% assumed to use relative isolation. Furthermore, 51.6% did not use gingival retraction/separation techniques and 34.4% use hemostatic solution associated with the gingival retraction cord. With regard the restorative materials, 67.7% stated that uses glass-ionomer cement (GIC) or resin-modified glass-ionomer cement (RMGIC) as liners depending on the cavity depth. The two-step etch and rinse adhesive systems were the most chosen one (61.7%)—where 82.7% of the dentists that consider self-etching systems assumed to use of phosphoric acid in enamel—and 56.4% prefer the use of hybrid/microhybrid resins to restore NCCLs. Considering restoration longevity based their clinicians experiences, only 8.3% (28) believe that NCCLs restorations can last for more than 5 years in service.

The Chi-square tests revealed no association among dentists' profiles and diagnostic attitudes. The only significant relations were verified between the form of remuneration and the method of isolation ($p=0.038$) and between the form of remuneration and the use of gingival retraction/separation techniques ($p=0.043$).

Discussion

Practice Based Research Network (PBRN) have a great potential to contribute with EBD, so it is mandatory to create groups joining the “real clinical practice” with the academia. A few years ago, the CRO-RJ established the Commission for Studies and Actions in an Evidence-Based Dental Research Network, which has the commitment to establish a better relationship with the regional dental surgeons regarding their attitudes and practices to provide clear data for better oral health promotion. This study presents a sequent evolution from a previous published pilot study [12]. Although an improvement was observed in the number of participants, one of the limitations of the current study is that only 23.8% responded the entire questionnaire. Part can be related to the fact that the CRO-RJ database was not fully updated, specially regarding the electronic mail addresses at that time. A huge upgrade was performed afterwards, aiming the electronic pools for the CRO-RJ presidency. Therefore, novel actions regarding the importance of participation and engagement on the studies are in progress.

In order to achieve a more accurate differential diagnosis of the etiology of NCCLs, the clinician should make a comprehensive medical and dental survey for each patient to successfully treat the etiology of such lesions. By addressing the interactive synergy of the active mechanisms—stress, friction, and biocorrosion, and their modifying factors—the clinician can then identify the complex etiology of these multifactorial lesions and preventive measures can be taken [8]. The obtained results revealed that although 77.2% of participants reported to distinguish between NCCLs types, 78.9% revealed to not employ any auxiliary diagnostic method. This fact may be related to the academic training in Dentistry, which, in general, does not apply specific tools to stimulate the search for scientific evidence and to elaborate diagnostic protocols directed to the determination of the probable etiological factors, differentiation and treatment of these lesions. Thus, it is fundamental that the diagnosis of NCCLs should be better addressed within dental schools and continuing education courses.

Moisture control can be an important factor for the success and longevity of restorations. In the present study, the majority of respondents (86.6%) mentioned to use the

cotton-roll technique (relative isolation) to restore NCCLs. It was also observed that both the type of isolation ($p=0.038$) and the gingival retraction/separations techniques ($p=0.043$) were dependent on the predominant form of remuneration, where the use of absolute isolation with rubber-dam and the use of gingival retraction/separations techniques were more related to private care. This data shows that the behavior of the dentists can be associated with the remuneration type. Similar results were found in other studies, that also revealed that the type of practice and the form of remuneration can influence clinical decisions [3, 13].

Questions remain about the real efficiency of the two main methods for moisture control. Although the use of rubber-dam associated with a retractor clamp is a proper method for gingival separation—allowing operatory access to the cervical margin of the lesion [11]—attention might be taken to possible damage to the periodontal tissues. In this way, the retractor cord can be also considered a good option for gingival clearance and to avoid contamination by bleeding and/or crevicular fluid [14–16]. A recent published study demonstrated that absolute or relative isolation techniques did not present statistical differences regarding the retention of restoration in NCCLs [14]. With regard gingival retraction, 51.6% of the dentists answered to not use separation techniques, and when the retractor wire was used, 34.4% associated with hemostatic. Therefore, education programs might highlight the importance of proper cleaning of hemostatic agents before the adhesive applications to improve the bond strength and to avoid premature pigmentation of the restoration margin.

Aesthetics and sensitivity control have been described as the main indications to restore NCCLs, directly interfering materials' choice [17, 18]. Although GIC and RMGIC have some specific characteristics, such as the chemical adherence to enamel and dentin, the fluoride release and consequent anti-cariogenic properties and the low annual failure rates in clinical follow-up [19, 20], composite resin is first choice for the vast majority of clinicians. This is probably related to aesthetic possibilities and ease of handling of this material's category [21]. In the present study, 67.7% of the dentists use the GIC or RMGIC, depending on the depth of the lesion, as the base or lining of the cavity to be restored.

Depending on the substrate, the adhesive procedure can be extremely challenging. The difficulty to establish a proper and durable bonding area in NCCLs is related to the modified histology of the affected dental structure, that presents hyper-mineralized dentin and denatured collagen, not ideal for the bond stability [22]. There are many studies on adhesive procedures in the cases of NCCLs and the best results are usually obtained with RMGIC and two-step self-etch adhesive systems [20, 21], with some variations among commercial brands. In general, the durable bonding area created by the two-step self-etch adhesives is attributed to a simple operatory technique, as the primer is applied on dry dentin, becoming less dependent on the operator. Additionally, the chemical adhesion to the dental structure, provided by the specific monomers, such as 10-methacryloyloxydecyl dihydrogenphosphate (10-MDP), is considered crucial [20–23].

In the present study, only 5.1% of the dentists consider to use two-step self-etch adhesive system as the first choice, while 61.7% consider two-step total-etch adhesive systems. This data can be alarming considering the fact that some products belonging to this category have induced very high annual failure rates in clinical studies [21]. A

hypothetical explanation for the popularity of this material's category could be related to the low cost of some commercial brands and the fact that the majority of the dental schools from the Rio de Janeiro State still consider these adhesives as the first choice for direct restorations in the dental clinics, regardless of the dental lesion origin and location. Another interesting information related to the adhesive procedures provided from the current study is that 82.7% of the dentists that reported the use of self-etch adhesive systems affirmed to always apply phosphoric-acid etching on enamel. This can be considered a positive attitude since recent data demonstrated that the chance of failure in NCCLs restorations tend to be reduced when using the technique of selective acid conditioning, although without statistical significances [21, 24].

Composite resin has been considered the material of choice to restore NCCLs due to the overall properties, the bonding ability to the dental adhesive, the ease of handling and the esthetic possibilities [21]. Besides that hybrid/microhybrid composites were preferred by the majority of dentist in the current survey (56.4%), there is no data in the literature that supports a superior composite for this type of restorative procedure. In vitro work demonstrates that materials formulated with smaller filler particles allow a better polishing of the restorations, favoring the maintenance of gloss and surface roughness when compared with materials formulated with larger filler particles, which could positively influence restorations longevity and periodontal response [25]. Clinical data is still necessary to properly support this hypothesis.

Regarding the longevity of NCCLs restorations, only 8.3% of dentists considered that they could last for more than 5 years. One theoretical explanation is that this general perception of low durability could be associated with the traditional use of two-step etch-and-rinse adhesive systems in Brazil, as also verified in the current survey with a group of dentists from the State of Rio de Janeiro. As previously discussed, the success of NCCLs restorations has intimate relation with the adhesive system of choice and the long-term studies show retention rates around 97% during 8 years of clinical follow-up when two-step self-etch adhesive systems with mild acidity are used [20]. On the opposite side, two-step etch-and-rinse adhesives are generally associated with the lowest retention rates [20]. As already stated, the majority of participants in the current survey do not apply specific tools to elaborate a proper diagnose of the NCCL. Therefore, this general perception of reduced longevity could also be associated with the lack of proper, methodical, methods to identify the real etiology of NCCLs.

Conclusions

According to the obtained results it is possible to conclude that:

- a. the majority of the respondents revealed to seek distinguishes among the different NCCLs types, but only a few declared to use auxiliary methods to support their diagnosis;
- b. the remuneration type affected attitudes regarding the isolation method;
- c. the two-step total-etch adhesive systems are the most used to restore NCCLs lesions;
- d. and that for the most part of the respondents the restorations of NCCLs made with resin composites do not last for more than 5 years.

Abbreviations

10-MDP: 10-methacryloyloxydecyl dihydrogenphosphate; ADA: American Dental Association; CEJ: cement enamel junction; CRO-RJ, Brazil: Regional Council of Dentistry of the State of Rio de Janeiro; EBD: evidence based dentistry; GIC: glass ionomer cement; NCCLs: non-carious cervical lesions; PBRN: Practice Based Research Network; RMGIC: resin modified glass ionomer cement.

Authors' contributions

All authors contribute evenly for this work. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The raw data of the current manuscript cannot be shared due the protection rules signed with the Ethics and Research Committee of Federal Fluminense University.

Consent for publication

All authors of the manuscript have read and agreed to its content and are accountable for all aspects of the accuracy and integrity of the manuscript in accordance with ICMJE criteria.

That the article is original, has not already been published in a journal, and is not currently under consideration by another journal.

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Ethics approval and consent to participate

This study was approved by the Ethics and Research Committee of Federal Fluminense University (#804.400). All participants filled the consent form and all the informed data is protected in secrecy.

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References

1. American Dental Association. Policy on evidence-based dentistry: definition of evidence-based dentistry. Chicago: ADA; 2008.
2. Gilbert GH, Williams D, Rindal B, Pihlstrom DJ, Benjamil PL, Wallace MC. The creation and development of the Dental Practice-Based Research Network. *J Am Dent Assoc.* 2008;139(1):74–81.
3. Kakudate N, Sumida F, Manabe K, Yokohama Y, Gilbert GH, Gordan VV. Restorative treatment thresholds for proximal caries in dental PBRN. *J Dent Res.* 2012;91(12):1202–8.
4. Bader JD, Levitch LC, Shugars DA, Heymann HO, McClure F. How dentist classified and treated non-carious cervical lesions. *J Am Dent Assoc.* 1993;124(5):46–54.
5. Bernhardt O, Gesch D, Schwahn C, Mack F, Meyer G, John U, et al. Epidemiological evaluation of the multifactorial aetiology of abfractions. *J Oral Rehabil.* 2006;33(1):17–25.
6. Senna P, Del Bel Cury A, Rösing C. Non-carious cervical lesions and occlusion: a systematic review of clinical studies. *J Oral Rehabil.* 2012;39(6):450–62.
7. Nascimento MM, Gordan VV, Qvist V, Bader JD, Rindal DB, Williams OD, et al. Restoration of noncarious tooth defects by dentists in The Dental Practice-Based Research Network. *J Am Dent Assoc.* 2011;142(12):1368–75.
8. Grippo JO, Coleman TA, Simring M. Abfraction, abrasion, biocorrosion, and the enigma of noncarious cervical lesions: a 20-year perspective. *J Esthet Restor Dent.* 2012;24(1):10–23.
9. Wood I, Jawad Z, Paisley C, Brunton P. Non-carious cervical tooth surface loss: a literature review. *J Dent.* 2008;36(10):759–66.

10. Lyttle HA, Sidhu N, Smyth B. A study of the classification and treatment of non carious cervical lesions by general practitioners. *J Prosthet Dent*. 1998;79(3):342–6.
11. Fahl N. Direct-indirect class v restorations: a novel approach for treating noncarious cervical lesions. *J Esthet Restor Dent*. 2015;27(5):267–84.
12. Modena RA, Pires AFS, Tannure PN, Cavalcante LMA, Schneider LFJ. Conhecimento de cirurgiões-dentistas sobre o diagnóstico e o tratamento de lesões cervicais não cariosas: um estudo piloto em rede colaborativa. *RFO, Passo Fundo*. 2016;21(2):178–86.
13. Gordan VV, Garvan CW, Heft MW, Fellows JL, Qvist V, Rindal DB. Restorative treatment thresholds for interproximal primary caries based on radiographic images: findings from the Dental Practice-Based Research Network. *Gen Dent*. 2009;57:654–63.
14. Loguercio A, Luque-Martinez I, Lisboa A, Higashi C, Oliveira Queiroz V, Rego R, et al. Influence of isolation method of the operative field on gingival damage, patients' preference, and restoration retention in noncarious cervical lesions. *Oper Dent*. 2015;40(6):581–93.
15. Kaneshima T, Yatani H, Kasai T, Watanabe EK, Yamashita A. The influence of blood contamination on bond strengths between dentin and an adhesive resin cement. *Oper Dent*. 2000;25:195–201.
16. Ebrahimi SF, Shadman N, Abrishami A. Effect of ferric sulfate contamination on the bonding effectiveness of etch-and-rinse and self-etch adhesives to superficial dentin. *J Conserv Dent*. 2013;16(2):126–30.
17. Schroeder M, Correa IC, Bauer J, Louguercio AD, Reis A. Influence os adhesive strategy on clinical parameters in cervical restorations: a systematic review and meta-analysis. *J Dent*. 2017;62:36–53.
18. Nascimento MN, Dilbone DA, Pereira PNR, Duarte WR, Geraldini S, Delgado AJ. Abfraction lesions: etiology, diagnosis, and treatment options. *Clin Cosmet Investig Dent*. 2016;8:79–87.
19. Santiago SL, Passos VF, Vieira AHM, Navarro MFL, Lauris JLP, Franco EB. Two-year clinical evaluation of resinous restorative systems in non-carious cervical lesions. *Braz Dent J*. 2010;21(3):229–34.
20. Van Meerbeek B, Peumans M, Poitevin A, Mine A, Van Ende A, Neves A, et al. Relationship between bond-strength test and clinical outcomes. *Dent Mater*. 2010;26(2):100–21.
21. Peumans M, De Munck J, Mine A, Van Meerbeek B. Clinical effectiveness of contemporary adhesives for the restoration of non-carious cervical lesions. A systematic review. *Dent Mater*. 2014;30(10):1089–103.
22. Heintze SD, Ruffieux C, Rousson V. Clinical performance of cervical restorations—a meta-analysis. *Dent Mater*. 2010;26(10):993–1000.
23. Van Meerbeek B, Yoshihara K, Yoshida Y, Mine A, De Munck J, Van Landuyt KL. State of the art of self-etch adhesives. *Dent Mater*. 2011;27(1):17–28.
24. Watanabe T, Tsubota K, Takamizawa T, Kurokawa H, Rikuta H, Ando S, et al. Effect of prior acid etching on bonding durability of single-step adhesives. *Oper Dent*. 2008;33(4):426–33.
25. Salgado VE, Cavalcante LM, Silikas N, Schneider LFJ. The influence of nanoscale inorganic content over optical and surface properties of model composites. *J Dent*. 2013;41(5):45–53.

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