# Association between Non-Carious Cervical Lesions (NCCLs) and Loss of Attachment in Patients with Periodontitis

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## Abstract

**Background:** Non-carious cervical lesions (NCCLs) are frequently found in clinical practice, however information on their prevalence, especially among patients with periodontitis is scarce.

**Objective:** To analyse in periodontitis patients the association between the severity of periodontal loss of attachment (LA) and NCCLs and to identify risk indicators related to NCCLs.

**Methods:** This is an observational cross-sectional study where patients with LA and at least 1 location with NCCL were included. NCCLs were measured based on the basic erosive wear examination (BEWE). Loss of attachment was recorded in a categorical scale between 0 and 3. All subjects completed a questionnaire on their medical and oral health status. Patient- and tooth-based statistical analyses were performed. Logistical regression models were used to determine the odds ratio (OR), confidence intervals (CI) and p-values.

**Results:** Ninety-three subjects with LA were included and 2,480 teeth were examined. More than 20% of the teeth were diagnosed with NCCLs. A statistically significant association between the presence of LA and BEWE at tooth-level was demonstrated (OR = 23.4; 95% IC [14.6; 37.3] p < 0.001). In addition, a statistical significant association between BEWE and LA for the different degrees of severities was found (p < 0.001). The strongest association was observed between LA > 5 mm and hard tissue loss > 50% (BEWE = 3) (OR = 66.1; 95% IC [8.7; 501.2]; p < 0.001). At patient level, no statistical significant association between LA and NCCL was found.

**Conclusions:** Within the limitations of this study, it can be concluded that in patients with periodontitis, severity of LA was significantly associated with the severity of NCCL at tooth level.

*Keywords: Non-Carious Cervical Lesion; NCCL; Basic Erosive Wear Examination; Periodontitis; Hypersensitivity; Gingival Recession*

## Introduction

Non-carious cervical lesions (NCCLs) represent loss of hard tissue structure (enamel and/or dentine) at the cervical area of the tooth, occurring predominantly at the labial surfaces [1,2]. Their prevalence has been reported to vary between 5 - 85% [3-6]. This variability is probably due to the use of different detection methods and case definitions.

These lesions have been frequently referred as abrasion (consequence of physical friction from toothbrush/dentifrice), bio-corrosion (consequence of chemical, biochemical and electrochemical degradation), and abfraction, associated to pathological occlusal forces [7,8]. The best available evidence, however, suggests that NCCLs have a multi-factorial etiology [9-14], including tooth-brushing, acid erosion, pathological occlusal forces, periodontitis and their combination [15], which is usually modified by individual variation [3,10,16]. While there is evidence that the frequency of tooth brushing, the use of specific tooth-brushing techniques and toothbrushes with increased bristle hardness are associated with development of NCCLs [17-19], data from individual studies are conflicting [2,10,20,21].

Periodontitis has also been proposed as a risk factor of NCCLs [13], although there is no evidence directly associating clinical loss of attachment (LA) and the NCCLs. Some studies, however, suggest that NCCLs appear more frequently in patients with high levels of plaque and calculus and/or periodontitis. Miller., *et al.* [13] found that abfractions often exist in teeth presenting plaque, calculus and periodontitis. Similarly, Mayhew., *et al.* [22] investigated the association of gingival attachment loss, tooth mobility and the percent of bone loss with the presence of NCCLs. It is also been hypothesised that history of periodontitis may be one important factor in the individual variation making some individuals more susceptible to the development and progression of these lesions [12]. All these studies have included small samples sizes and crude methods to evaluate both LA and NCCLS. It was, therefore, the purpose of this investigation to study the association between LA and NCCLs, both at patient and tooth level and to describe patient reported outcomes (PROMs).

## Materials and Methods

### Study design

This cross-sectional observational study was carried out in two centres, the Faculty of Odontology of the University Complutense of Madrid (Spain) and the Department of Epidemiology (EDISS) of University of Lyon (France) once it was approved by the CNIL Ethics Committee. This study was conducted in conformity with the principles embodied in the Helsinki Declaration (1964) (reviewed Seoul (2008)) and with the norms of Good Clinical Practice of Harmonization International Conference (CPMP/ICH/135/95). Participating subjects were informed on the nature of the study and were asked for their voluntary participation. Once agreed they signed the ethical committee approved informed consent.

### Study subjects

Subjects ranging 35-74 years were consecutively recruited from those attending the Postgraduate Periodontal Clinic at the University of Complutense (Madrid, Spain) and the Department of Epidemiology of University of Lyon (Lyon, France) between March 2010 to March 2012. Patients were included if they were diagnosed of chronic or aggressive periodontitis [23] either untreated or after being treated (currently enrolled in a periodontal maintenance programme) and demonstrating at least one location with NCCL. Subjects were excluded if they (1) were under antibiotic coverage; (2) had received analgesics within the last 24 hours or were currently under topical anti-inflammatory therapy; (3) had bleeding disorders (e.g. those taking anticoagulant medications and haemophiliacs); or (5) had any other systemic disease, which may alter the local inflammatory response.

### Study outcomes

Each subject received a dental and periodontal examination and was asked to complete a comprehensive health and habits questionnaire.

### Periodontal examination

One examiner in each centre (S.B., M.R.) undertook all the periodontal examinations using a pressure sensitive periodontal probe set up at 20g (PDT Sensor probe Type US Williams). Loss of attachment was measured to the nearest mm at four sites in all teeth (mesio-buccal, mid-buccal, disto-buccal, mid-lingual) and was categorized into: slight (1 - 2 mm), moderate (3 - 4 mm) and severe (5 mm or more).

**Examination of NCCLs**

The Basic Erosive Wear Examination (BEWE) is considered as a simple, reproducible and transferable scoring system for diagnosing and grading NCCLs [4]. Once the teeth were cleaned with a cotton pellet, each surface was visually graded using the two-digit BEWE codes (Table). The first digit depicts the severity code and the second the location (anatomic crown cervical, anatomic root cervical and crown and root cervical). Tooth wear severity was graded in four scores: no surface loss (0), initial loss of enamel surface texture (1), hard tissue loss less than 50% of the surface area (2), or hard tissue loss more than 50% of the surface area (3). Buccal/facial and lingual/palatal surfaces were examined recording the highest score (two locations per tooth).

| BEWE Codes (Lussi, 2008) | |
|---|---|
| | **Location Codes** |
| 0 = No erosive wear | 0 = Anatomic crown and over cervical localization |
| 1 = Initial loss of surface texture | 1 = Anatomic crown in cervical localization |
| 2 = Distinct defect, hard tissue loss minor than 50% of the surface area (clinical crown) | 2 = Anatomic root in cervical localization |
| | 3 = Anatomic crown and root cervical localization |
| 3 = Hard tissue more or equal than 50% of the surface area (clinical crown). | |

*Table*

**Patient reported outcomes (PROMs)**

All individuals were interviewed at the time of the clinical examination using a questionnaire with closed questions. This questionnaire has been used in previous studies on tooth wear and dentine hypersensitivity [24,25]. Participants were asked about their medical history, demographic and socio-economics profile, dietary habits, oral hygiene habits and perceived hypersensitivity (Appendix 1).

**Calibration**

Examiners were calibrated for NCCL and LA measurements. In the case of NCCL, each examiner reviewed 40 NCCLs pictures. In the case of LA, 5 patients were examined. The reproducibility in terms of BEWE scored 71% (kappa = 0. 29).

**Sample size**

Based on previous studies with a similar methodology (n = 43 patients (22); n = 61 patients (13) and n = 30 patients (26)), a convenient sample of 90 subjects was chosen.

**Data analysis**

Loss of attachment was considered the independent outcome of the study and was categorized as: slight, moderate and severe. The primary outcome variable was the severity of tooth wear evaluated by the BEWE system.

Descriptive statistics were used to determine the frequency distribution of PROMs questionnaire (socio-economics, demographic, dietary and hygienic characteristics), NCCLs and its association with LA. Multinominal logistic regression analyses (IBM SPSS Statistics 19.0; IBM Corporation, Armonk, NY, USA) were constructed for NCCL and LA severity grades, at tooth and subject-level, respectively.

**Tooth-level analysis**

At tooth level, the independent and dependent variables were categorised according to the severity grades previously defined

**Subject-level analysis**

The subject-based data analysis was carried out considering two severity grades for LA (slight-moderate (LA = 1 - 4 mm) vs severe (LA > = 5 mm) and slight (LA = 1 - 2 mm) vs moderate-severe (LA > = 3 mm)) and two degrees of NCCL extension (a) at least one NCC lesion

per quadrant or b) at least on NCC lesion per patient). In addition, for the regression analysis, BEWE was categorized as necessary to treat (BEWE = 2 - 3) and not necessary to treat (BEWE = 1 - 2).

Results were presented as odds ratio (OR), 95% confidence interval (CI), and p values. P-values ≤ 0.05 were considered statistically significant.

## Results

### Study population

A total of 93 patients [mean age = 56.96 yrs (SD = 10.42)] were included in the study. In the sample, 64.8% of the subjects (n = 59) were women and 72% (n = 67) were non-smokers.

### Tooth-level analysis

A total of 2,480 teeth were examined. The periodontal examination resulted in 37.26% of the teeth being healthy and 22.98%, 27.02% and 12.74% presenting slight, moderate and severe LA, respectively. The dental examination resulted in 20.1% of the teeth presenting NC-CLs, from which 8.1%, 10.2% and 2.7% presented severity BEWE code type 1, 2 and 3 respectively. Forty-six percent (46.6%) of the NCCLs were located in the root cervical location, 33.6% in crown and root cervical location, 17.7% in the crown cervical location and 2.1% in the anatomic crown and other cervical location.

Data from the statistical model at tooth-level is presented in table 1 showing a statistical significant association (p < 0.001) between BEWE and LA for the different degrees of severities. The strongest association was observed for teeth with LA greater than 5mm and hard tissue loss greater than 50% (BEWE = 3) (OR = 66.1; 95% IC [8.7; 501.2]; p < 0.001).

| Healthy | | LA tooth | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Slight (1-2mm) | | | | Moderate (3-4mm) | | | | Severe ( > = 5mm) | | | | |
| | | % * | % | OR | 95%CI | p value | % | OR | 95%CI | p value | % | OR | 95% CI | p value |
| **BEWE** **Severity** | Initial loss of surface texture | 0.5 | 11.8 | 29.9 | 11.9; 74.8 | 0.000 | 13.4 | 38.9 | 15.7; 96.5 | 0.000 | 13.3 | 34.7 | 13.6; 88.7 | 0.000 |
| | Distinct defect (hard tissue loss < 50%) | 1.4 | 12.1 | 11.8 | 6.5; 21.7 | 0.000 | 20.5 | 22.8 | 12.8; 40.8 | 0.000 | 12.3 | 12.4 | 6.5; 23.6 | 0.000 |
| | Hard tissue loss > = 50% | 0.1 | 4.8 | 61.2 | 8.3; 452.2 | 0.000 | 3.6 | 52.5 | 7.1; 389.1 | 0.000 | 5.1 | 66.1 | 8.7; 501.2 | 0.000 |

***Table 1:*** *Association between severity of Basic Erosive Wear Examination and severity of Lost of Attachment at tooth level analysis.*
*\*Teeth without loss of attachment (healthy) were considered the reference category.*

*CI: Confidence Interval.*

### Patient level analysis

From the 93 patients, 61.29% present at least one location with LA severe and the remaining, 32.26% at least one location with LA moderate and 6.45% slight. No statistical significant association between LA and NCCL was found at patient level. There was a slight

tendency towards significance when comparing slight (LA = 1 - 2 mm) and severe (LA > 3 mm) LA in patients with at least 1 NCCL per quadrant (OR = 3,6; 95%IC (0.9; 14.5); p < 0.06). Frequency distributions, ORs and p-values are presented in tables 2 and 3.

|  | LA 1 - 2 mm | LA > = 3 mm | OR | 95% CI | p-value |
|---|---|---|---|---|---|
| **1 location per quadrant** | | | | | |
| BEWE 0-1 | 47 (94.0%) | 35 (81.4%) | 3.6 | 0.9; 14.5 | 0.06 |
| BEWE 2-3 | 3 (60.0%) | 8 (18.6%) | | | |
| **1 location per mouth** | | | | | |
| BEWE 0-1 | 6 (16.7%) | 13 (22.8%) | 0.4 | 1.5 | 0.47 |
| BEWE 2-3 | 30 (83.3%) | 44 (77.2%) | | | |

*Table 2*: Regression model results and frequencies of Basic Erosive Wear Examination (BEWE) and Loss of Attachment (LA) at patient level considering loss of attachment as LA = 1 - 2 mm or LA > = 3 mm. Defects with BEWE codes 0 and 1 with were considered not necessary to treat. Defects with BEWE codes 2 and 3, where treatment is needed.

|  | LA 0-4 | LA > = 5 mm | OR | 95% CI | p-value |
|---|---|---|---|---|---|
| **1 location per quadrant** | | | | | |
| BEWE 0-1 | 72 (87.0%) | 10 (90.9%) | 0.7 | 0.1; 6.2 | 0.76 |
| BEWE 2-3 | 10 (12.0%) | 1 (9.1%) | | | |
| **1 location per mouth** | | | | | |
| BEWE 0-1 | 6 (16.0%) | 13 (22.8%) | 7 | 0.2; 1.9 | 0.26 |
| BEWE 2-3 | 30 (83.0%) | 44 (77.2%) | | | |

*Table 3*: Regression model results and frequencies of Basic Erosive Wear Examination (BEWE) and loss of attachment (LA) at patient level considering loss of attachment as LA = 0 - 4 or LA > = 5 mm. Defects with BEWE codes 0 and 1 with were considered not necessary to treat. Defects with BEWE codes 2 and 3, where treatment is needed.

**Patient Reported Outcomes (PROMs)**

Table 4 depicts the descriptive analysis on the factors retrieved from the PROMs questionnaire (demographics, socio-economics, diet and hygienic habits).

In the diet questionnaire, 52.7% of the patients reported consuming fresh fruit every day; 35.5% and 12.8% of the patients reported consuming fresh fruit and fruit juices several times daily, respectively and 8.7% reported consuming soft drinks with the same frequency.

| Questionnaire data n (%) | | | |
|---|---|---|---|
| Oral hygiene habits | Diet | Habits | Reported patients feelings |
| **Daily brush frequency** Once a time 5 (5.2%) Twice 31 (32.3%) More than twice 58 (60.4%) Never 1 (1.0%) Not available 1 (1.0%) | **Fresh fruit intake** Several times a day 5 (35.5%) Every day 49 (52.7% Seldom/Never 12 (11.8%) | **Vomits** Once a time 5 (5.4%) | **Hypersensibility feeling** Often 32 (33.9%) Occasionally 38 (39.3% Hardly ever/Never 24 (25.0%) Not available 2 (2.0%) |
| **Oral hygiene devices as first option** Manual toothbrush 83 (86.5%) Electric toothbrush 10 (10.4%) Interdental toothbrush 1 (1.0%) Not reported 1 (1.0%) Not available 1 (1.0%) | **Lemon intake** Several times a day 5 (5.5%) Every day 8 (6.6%) Seldom/Never 85 (87.9%) **Juice fruits intake** Several times a day 12 (12.8%) Every day 15 (16.0%) Seldom/Never 69 (71.2%) | **Clench teeth (night)** Once a time 27 (26.9%) | **Hypersensibility origin** Brushing 13 (13.5%) Touching 4 (4.2%) Cold water 50 (52.1%) Jet of air 5 (5.2%) Not know/reported 15 (15.7%) |
| **Interdental brush frequency** Several times a day 22 (22.9%) Every day 36 (37.5%) Seldom/never 26 (27.0%) Not reported 4 (4.2%) Not available 8 (8.3%) | **Soft drinks intake** Several times a day 8 (8.7%) Every day 6 (6.5%) Seldom/never 82 (84.8%) | **Creak teeth (day)** Once a time 16 (16.1%) | **Gingival recession appearance** Often 4 (4.1%) Occasionally 5 (5.2%) Hardly ever/Never 84 (87.5%) Not reported 2 (2.1%) Not available 1 (1.0%) |
| **Horizontal brushing** Once 20 (20.8%) More than once 33 (34.4%) Never 34 (35.4%) Not know/reported 6 (6.3%) | **Alcohol/wine intake** Several times a day 3 (3.3%) Every day 24 (25.0%) Seldom/never 69 (71.7%) | **Visit periodontist** Bleeding gums 22 (23.5%) Teeth mobility 10 (11.8%) Gingival recession 17 (20.0%) Hypersensitivity 6 (7.0%) Others/Not sure 41 (37.7%) | |

*Table 4*

In regards to oral hygiene habits, 60.2% of patients brushed their teeth more than twice per day, 84.0% used a manual toothbrush and 59.3% used a horizontal technique more than once a day.

Other related factors as vomits, creak teeth and clenching teeth, were presented in a 5.4%, 26.9% and 16.1% of the sample, respectively. Hypersensitivity was reported in 33.3% of the subjects, being cold water the main trigger for discomfort.

## Discussion

The aim of this study was to test the hypothesis that the severity of LA was related to the presence of NCCLs. In the tooth-level analyses, there was a statistical significant association ($p < 0.001$) between BEWE and LA for the different degrees of severity. In the patient-level analysis, however, no statistically-significant association between BEWE and LA was found. There was, however, a clear tendency between severe LA (> 5 mm) and subjects with at least 1 NCCLs per quadrant ($p < 0.06$). Few observational studies have evaluated this association and none using BEWE as the method to identify and grade NCCLs. Most of the previous studies have associated NCCLs with probing pocket depths and/or gingival recession [13,26,27]. In the study by Miller., *et al.* (2003) abfraction lesions were often present in patients presenting plaque (40.1%), calculus (41.7%), or periodontitis (20.4%). On the contrary, Pickdoken., *et al.* [26] reported in a retrospective study that cervical wear was significantly associated with less plaque accumulation and the presence of shallow pockets. In this study, teeth with advanced gingival recessions were 2.58 times more likely to develop deeper cervical lesions. This study, however, did not provide information on the selection criteria to consider a patient with NCCL or a patient with periodontitis.

A systematic review and meta-analysis to study the available evidence for the effect of tooth-brushing on the initiation and progression of gingival recession and NCCLs could not make definite conclusions due to the heterogeneity of the published data [27]. Conversely, during the consensus report of working-group 4 of the 11th European workshop on Periodontology, authors reported that local and patient-related factors were highly relevant in the development and progression of NCCLs associated with tooth-brushing, identifying abrasions and gingival recessions as the tooth-related factors and erosion as the patient-related factor [2]. Furthermore, these previous studies when reporting the association between gingival recession and NCCLs, they did not distinguish the etiology of the recession, either resulting from inflammation or periodontitis or due to mechanical trauma mainly from tooth-brushing. Consequently, this is the first study were LA in periodontitis patients or those with a history of periodontitis demonstrated a significant association with presence of NCCLs at tooth level. A potential mechanism for this association has been attributed to the acidic nature of mature bacterial plaque and gingival crevicular fluid [28]. In the present study, almost 50% of the NCCLs diagnosed were located on the cervical part of the root while only 17.7% where on the cervical part of the crown. Data from this study, however, might also support the possible role of trauma from tooth brushing [2] or acidic dietary intake [29] in the development of these lesions. More than 50% of the patients brushed more than twice per day (60.4%) or reported consuming fresh fruit every day (52.7%). In addition, 34.4% performed a horizontal brushing technique and 35.5% reported consuming fresh fruit several times a day.

NCCLs associated with gingival recessions may be considered one of the main esthetic concerns in modern dentistry. The treatment of these clinical situations requires the fulfillment of both the biological and esthetic goals, which are critical for achieving adequate patient satisfaction. In fact, several authors have proposed therapeutic algorithms to improve the esthetic predictability when treating the gingival recessions associated to NCCLS [30].

This cross-sectional study, however, has clear limitations since it has used a convenient sample, which may be not representative of all periodontitis subjects. Furthermore, the lack of a control group (no periodontal affectation) and the limited sample size may limit the conclusions reached by this investigation.

## Conclusions

Within the limitations of this study, it can be concluded that in patients with periodontitis, there was a significant association between the severity of LA and the severity of NCCLs at tooth level. The patient level data showed a clear tendency towards this association although it did not reach statistical significance. In the light of this findings, it would be interesting to design appropriate studies to validate this hypothesis of periodontitis as a risk or predisposing factor for NCCLs.

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