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Predictors of Non-carious Loss of Cervical Tooth Tissues

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Clinical Relevance

In this sample of subjects, age, premolars and the presence of corrosive factors were found to be significantly associated with NLCTT. The long-term success of treating such a lesion is dependent on properly identifying and eliminating the etiologic factors.

SUMMARY

This Predictor Variables study is designed to determine which one of 11 factors evaluated may be correlated to Non-carious Loss of Cervical Tooth Tissues (NLCTT) using subjects with and without NLCTT. The ultimate objective is to successfully predict the path toward risky behaviors and reduce the incidence of NLCTT.

INTRODUCTION

Non-carious loss of cervical tooth tissues (NLCTT) is a frequent finding in contemporary dental practices (Blunck, 2001). In the literature, NLCTT is synonymous with a non-carious cervical tooth lesion (NCCL) and has been described as a complex, multifactorial phenomenon involving erosion, abrasion, tooth flexure and their possible interactions.

Prevalence studies of NLCTT have generally been carried out using samples of convenience, investigating only teeth with NLCTT. It is suggested that high occlusal loads result in large stress concentrations in the cervical region of the teeth (Figure 1). These stresses may be high enough to cause disruption of the bonds between the hydroxyapatite crystals, eventually resulting in the loss of cervical enamel. NLCTT frequently occurs in areas not associated with high occlusal load or stress concentrations (Figure 2).

Although *in vitro* studies and Finite Element Analysis (Geramy & Sharafoddin, 2003) demonstrated that tooth flexure disrupts the bonds between enamel rods, causing microfractures and, eventually, loss of tooth substance, the earlier hypothesis of Lee and Eackle (1984) has not been substantiated with clinical research (Litonjua & others, 2003).

This study differs from previous investigations in that both teeth with and without NLCTT are used. It was a clinical trial, and factors related to heavy occlusal forces were evaluated on a tooth-by-tooth basis rather than by a general assessment of the mouth.

This study investigated a possible correlation between the presence and absence of NLCTT and 11 factors that have been reputed to cause NLCTT. The hypothesis that there was no correlation was tested against the hypothesis that some or all of the factors exhibited a statistically significant correlation at the 5% level.

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DOI: 10.2341/04-180

Figure 1. *Premature loss of the right maxillary canine might have resulted in the lack of a canine-protected occlusion and, hence, the appearance of lesions in the premolar region.*

Figure 2. *The appearance of NLCTT in the lingual of the first and second right maxillary molars cannot be explained by high occlusal load or stress concentration, alone.*

Table 1: *Criteria for NLCTT Evaluation*

The Presence of Habits/Conditions That May Contribute to NLCTT

These independent or predictor variables were assessed by visual examination:

1. Wear Facets: Divide the tooth in half buccal-lingually and note the presence of wear facets.
    a. Minor: The facet is definite but there has not been any significant vertical loss of enamel.
    b. Mild: There has been significant vertical loss of enamel but not sufficient to encroach upon the dentin.
    c. Moderate: The enamel has been thinned enough to be able to determine that the dentin is almost exposed.
    d. Severe: There is exposed dentin.
2. Signs of TMD
3. ROM: Determine if the range of motion is within normal limits (normal > 40 mm; restricted <40 mm)
4. Soreness of TMJ: Palpate the joint to determine if there is pain.
5. Tooth and occlusal factors:
    a. premolar or molar
    b. occlusal factors:
        occlusal contacts present:
        i. MI maximum intercuspation
        ii. W working
        iii. NW non-working

The patient was asked about presence of contributing factors that might explain the cervical defect.

6. Symptoms of TMD; Ask the patient if he/she has a history of bruxing or clenching, pain in the joint or musculature or TMD therapy.
7. Corrosive factors:
    a. Diet high in fruits, fruit juices, carbonated beverages or sports drinks?
    b. Acid reflux?
8. Completely subgingival NLCTT present.
9. Tooth brush abrasion:
    a. Hard brush?
    b. Excessive pressure?
    c. Abrasive toothpaste?
10. Age
11. Sex

METHODS AND MATERIALS

Eighty individuals recruited at random from the medical campus and surrounding community were informed about the project and gave their written consent to participate. All were people who presented for screening for a study of resin-based composite restorations on posterior teeth. To be eligible for this study, potential participants had to be 21 years old, in good health and in need of Class II restorations on molars or premolars. These restorations could be required either because of caries, a faulty restoration and/or dissatisfaction with the appearance of an existing restoration. As part of the screening process, all potentially eligible teeth were evaluated for 11 factors theorized as causing NLCTT. Using a combination of clinical examination and interview, the presence or absence of these 11 factors was determined (Table 1).

The outcome or dependent variable of interest was the presence of a cervical defect. No measurement of size was made. With one exception, no judgment was made as to possible etiology. The exception was that abfraction was defined as a lesion that was totally subgingival.

These independent or predictor variables were assessed by visual examination: 1) wear facets; 2) signs of TMD; 3) range of motion (ROM); 4) soreness of TM joint to palpation and 5) whether the tooth was a molar or premolar. Occlusal contacts were evaluated using occlusal registration strips (Artus Corp, Englewood, NJ, USA). The following were assessed by interviewing the participant: 6) symptoms consistent with TMD; 7) a diet high in acidic foods; 8) acid reflux; 9) abrasive brushing materials/techniques; 10) age; 11) sex. A detailed chart is depicted in Table 1. Table 2 shows how the significant variables were assigned.

The results were analyzed using a Multiple Logistic Regression using the following general model:

$$\text{Logit } P = \alpha + \beta_1 x_1 \ldots + \beta_k x_k$$

Where P is the probability of NLCTT

α is a constant

$x_1, \ldots x_k$ are a collection of independent variables

$\beta_1 \ldots \beta_k$ are regression coefficients

The format for a logistic regression is that the dependent and independent variables be binary. Where the independent variables allowed for multiple responses, the data was converted to a binary response by using dummy variables. Logistic regression was used in a forward step-wise fashion. This approach controls for covariance.

RESULTS

Fifty-two percent of teeth had wear facets on the buccal half of the tooth and 34% on the lingual half. Eighty-five percent had MI contacts, 36% working and 21% non-working contacts. Six subjects had NLCTT on each tooth that was examined, 24 had NLCTT on some teeth and 50 had no NLCTT. Thirteen subjects reported corrosive factors and 18 reported abrasive factors. Twenty-nine subjects reported a history of TMD, limited ROM and/or TMJ soreness.

The predictor model that fit best included the following three independent variables:

$$\text{Logit } P = -4.199 + [1.010 * \text{tooth } (X_1)] + [1.933 * \text{Age } 30s(X_{2i})] + [2.365 * \text{Age } 40s(X_{2ii})] + [2.946 * \text{Age } 50s(X_{2iii})] + [16.452 * \text{Age } 60s(X_{2iv})] + [2.290 * \text{corrosive}(X_3)].$$

Table 3 shows the details of the logistic regression equation. NLCTT was significantly associated with age, premolars and corrosive factor (Multiple Logistic Regression; $p<0.001$ to $p<0.046$, respectively). Note that the constant α is a negative number, meaning that there is an inverse relationship between the data and the constant. So, when the independent variable X_1, all X_2s and X_3 equal zero, the model predicts a negative likelihood of there being NLCTT present. That represents a molar (X_1), a person in his or her 20s (X_2) and a person who reports no history of habits or conditions that are corrosive (X_3). No other independent variables were of significant value in predicting the presence of NLCTT.

Since the ages of all participants ranged between 22 and 67 years (average age being 40), this response was not binary. Accordingly, dummy variables X_{2i} through X_{2iv} were created to convert this data to a binary response. To accurately investigate the significance of the age data, all of the dummy variables representing age must be included in the model, even though Age 30s (X_{2i}) and Age 60s (X_{2iv}) do not individually exhibit significant p values. So, while X_2 as a group exhibits a significant association with NLCTT, three subgroups do not. The best explanation is that the authors lacked sufficient numbers in the 60s age group, and participants

Table 2: *Description of Significant Variables*

	Binary Response	
	1	0
Tooth	premolar	molar
Age	Dummy variables	20s
Corrosive Factor	Presence of corrosive factors	Absence of corrosive factors

Table 3: *Details of the Logistic Regression Equation*

Logit P = -4.199 + [1.010 * tooth (X_1)] + [1.933 * Age 30s (X_{2i})] + [2.365 * Age 40s(X_{2ii})] + [2.946 * Age 50s(X_{2iii})] + [16.452 * Age 60s(X_{2iv})] + [2.290 * corrosive(X_3)]

Ind Variable	Coefficient	Standard Error	Wald Statistic*	*p* value
Constant	-4.199	1.036	16.424	<0.001
X_1 Tooth	1.010	0.368	7.534	0.006
X_{2i} Age 30s	1.933	1.069	3.273	0.070
X_{2ii} Age 40s	2.365	1.058	4.991	0.025
X_{2iii} Age 50s	2.946	1.072	7.549	0.006
X_{2iv} Age 60s	16.452	406.695	0.00164	0.968
X_3 Corrosive	2.290	0.635	12.986	<0.001

**Wald chi-square statistics*

in their 20s and 30s were borderline groups for the development of NLCTT.

Finally, for X_3, no report of corrosive habits relates to a less likelihood of developing NLCTT. The presence of acid reflux disease and a diet high in fruits, fruits juices, carbonated beverages or sports drinks were, however, associated with NLCTT. Conversely, a history of a hard toothbrush, an abrasive toothpaste and/or the use of excessive pressure was not significantly associated with NLCTT.

DISCUSSION

Eighty individuals screened for a study on posterior restorations of resin-based composite were included. In terms of the participants chosen, this was a random sample. In terms of the specific teeth, only those teeth in need of a Class II restoration were considered. However, there is little reason to believe that the need for a restoration created a biased sample. The sample is random in terms of the way the people were chosen. One prevalence study looked at a non-random sampling of 48 dental students (28 males; 20 females) between the ages of 16 and 24 years (Telles, Pegoraro & Pereira, 2000). A recent study looked at 61 patients presenting with abfraction lesions (Miller & others, 2003). Unlike other studies that only look at teeth where NLCTT is present, all the teeth that were evaluated were potentially eligible to qualify for the study.

Logistic regression analysis attempts to determine if any of the independent variables can predict the dependent variable. In this case, the authors were analyzing the data to see which, if any of the factors they measured could predict the presence of NLCTT. The dependent variable must take one of two possible outcomes: absence or presence of factors. The independent variables must take a 1 or 0 variable, as well. When the independent variables do not fit, they can be modified by creating dummy variables. If an independent variable has three responses, two dummy variables are created. For example, a response may have three possible responses, 1, 2 or 3. Two dummy variables are created—X_1 and X_2. These two dummy variables can take only three possibilities: both X_1 and X_2 can be 0, X_1 can be 1 and X_2 can be 0, and X_1 can be 0 and X_2 can be 1. These three possibilities equate to the original choice of 1, 2 or 3, respectively. When determining the most accurate fit for this model, it would not be appropriate to include X_1 in the model but not X_2, and vice versa.

The multiple logistic analysis controls for co-linearity. Because wear increases with age, age and severity of wear would be expected to be co-linear. Analyzed separately, both occlusal wear and age may be significant predictors. When analyzed together, logistic regression is able to determine whether age or wear is the better predictor. By including the independent variables in a step-wise fashion, one can determine whether the addition of wear adds significantly to the fit of the model beyond age alone.

NLCTT appears to have a multifactorial etiology: it can be perceived as a problem of increased retention of dentition into older age. In this study, age has been found to be a reliable predictor of NLCTT. The outcome assessment might be even stronger, considering the average age of subjects was 40 years of age. This is in agreement with a recent prevalence study in a population from the city of Rijeka, Croatia, that examined 18,555 teeth from the permanent dentition (Borcic & others, 2004). Their findings indicated that the prevalence of NLCTT and the severity of these lesions increased with age. In another study that examined samples of prehistoric, historic and modern populations from the South of France, the authors' data also suggested that the prevalence of NLCTT increases with age and is higher in females (Aubry & others, 2003).

Modern diet may also play a role in etiology. The low pH value of common beverages may have a significant corrosive role. Other factors that were cited include the buffering capacity of beverages, and especially of saliva. Thirteen subjects reported corrosive factors in this study. Brushing techniques have been associated with tooth loss in the cervical region, with the horizontal technique being more traumatic than the circular or combined technique. In this study, 18 subjects reported abrasive factors. Twenty percent of the subjects in this study reported a history of TMD problems. At the time of examination, a lower percentage, 12.5%, exhibited TMJ tenderness on palpation and 3.8% exhibited compromised ROM.

In this study, only 8.78% of subjects had defects that were completely subgingival. An investigation of young adults with Class I occlusions showed that occlusal contact was 79.9% for all teeth. Furthermore, the highest percentage of all teeth in contact was found between the first molars at 21%. In this study, the percentage of teeth with MI contact was close to 85%. If occlusion was the dominant factor for NLCTT, one would expect to find molars to be a good predictor. However, the results of this study indicated premolars to be a better predictor of NLCTT. Borcic and others (2004) also found that the lower premolars had the greatest NLCTT, with a greater severity of lesions. A recent study looked at 61 patients presenting with abfraction lesions and concluded that clinical signs of excessive brushing were lacking, whereas signs of occlusal disturbance were very consistent with NLCTT (Miller & others, 2003).

Treatment of NLCTT is a challenging issue and includes a variety of options, such as a procedure as simple as adhesive penetration with dentin bonding agents or complex treatment with composite or porcelain veneers and crown and bridge work (Lambrechts &

others, 1996). The most common modality is that of restorations with resin composites, glass ionomers, resin-modified glass ionomers and compomers (Lyttle, Sidhu & Smyth, 1998). Several reports have indicated that resin bond strengths to non-carious sclerotic cervical dentin are lower than bonds made to normal dentin. Tay and Pashley (2004) suggested that, when bonding resin to sclerotic dentin, bonding should be extended to include peripheral sound dentin to permit the retention of Class V restorations by adhesion, without additional retention. A recent clinical study for the restoration of NLCTT reported a 96% retention rate for resin-modified glass ionomers and 81% for resin composites (Brackett & others, 2003). Of note was the color match rating, with resin composite restorations having a 100% alpha rating in color match versus 85% for resin-modified glass ionomers. In the region of premolars, one might consider esthetics to be an important parameter. However, in a three-year clinical study, lesions restored with resin composite and a dentinal bonding agent exhibited the highest percentage of lost restorations (Neo & Chew, 1996). When considering the choice of hybrid or microfine composites, no difference between retention rates for the two groups was found after 24 months, bringing into question the role that a material's stiffness plays in determining retention in a non-carious Class V lesion (Browning, Brackett & Gilpatrick, 2000). Compomers performed poorly in NLCTT (Brackett & others, 2001).

CONCLUSIONS

In this sample of subjects, only age, premolars and corrosive factors were found to be significantly associated with NLCTT.

(Received 18 October 2004)

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