Brief Communication: Study of Noncarious Cervical Tooth Lesions in Samples of Prehistoric, Historic, and Modern Populations From the South of France

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ABSTRACT Noncarious tooth lesions (NCTL) are frequent findings in contemporary dental practices. Unlike other dental and periodontal diseases, NCTL have not been studied in an anthropological context. The purpose of the present study was to compare the prevalence of NCTL in three archaeological samples from the Copper Age and Middle Ages and in subjects examined in three dental practices. Both archaeological samples and dental-practice subjects were from southern France. In the archaeological sample group, no NCTL were detected in 3,927 teeth from 259 individuals. In the dental-practice group, prevalence rates were in agreement with current epidemiological data. Our data also suggest that prevalence of NCTL increases with age and is higher in females. Premolars were the most affected tooth type. Occurrence of NCTL has long been attributed to toothbrushing and to erosion by intrinsic and extrinsic acids. More recently, occlusal stress associated with tooth flexure has been implicated. The reasons underlying the total absence of NCTL in archaeological samples are discussed. The most likely explanations involve differences in lifestyle, diet, and dental condition. Am J Phys Anthropol 121:10–14, 2003.

Noncarious cervical tooth lesions (NCTL) are defects resulting from the loss of hard dental tissues in the region of the cementoenamel junction. Unlike caries, NCTL are not of bacterial origin, and the bottom of the defect is hard. They occur in various shapes, including shallow grooves, dished-out lesions, or wedge-shaped defects (Fig. 1), and in various sizes, ranging from small lesions detectable only by passing a probe over the tooth to large defects. These morphologies can involve any type of tooth (Sognnaes et al., 1972; Levitch et al., 1994), and several teeth can be affected in the same individual. Although the buccal surface appears to be most frequent location (e.g., 97% of 178 lesions reported by Mayhew et al., 1998), lingual and interproximal surfaces may also be affected. Probably because NCTL are seldom associated with extensive damage requiring treatment (pulp exposure and abscess), there is a paucity of scientific data on the subject.

Numerous studies have investigated the occurrence of dental pathological conditions in archaeological remains from the Paleolithic until now. Comparative data indicate that there has been a dramatic increase in caries, periodontal disease, and malocclusion (Wells, 1975). However, NCTL, which are widespread in modern populations (Levitch et al., 1994), have not been extensively studied within an anthropological context. Because the etiology of NCTL is not well-known, numerous terminologies have been used, including abrasion cavities, erosion cavities, wedge-shaped defects, cervical notches, idiopathic cervical lesions, and abfraction lesions. As previously proposed (Bader et al., 1996), the term "noncarious cervical tooth lesions" has been used in this paper to avoid the implication of any specific etiology.

The etiology of NCTL appears to be multifactorial and complex (Levitch et al., 1994; Bader et al., 1996; Mayhew et al., 1998). Various mechanisms have been incriminated, including toothbrushing (Miller, 1907) and erosion due to extrinsic and intrinsic acids (Stafne and Lovestedt, 1947). More recently, NCTL were attributed to microfractures in the enamel induced by occlusal stress associated with tooth flexure during mastication and parafunctions. Defect shape is not helpful in determining the underlying cause, since the aforesaid factors may act separately, simultaneously, or successively (Lee and Eakle, 1984; Bader et al., 1996; Braem et al., 1992).

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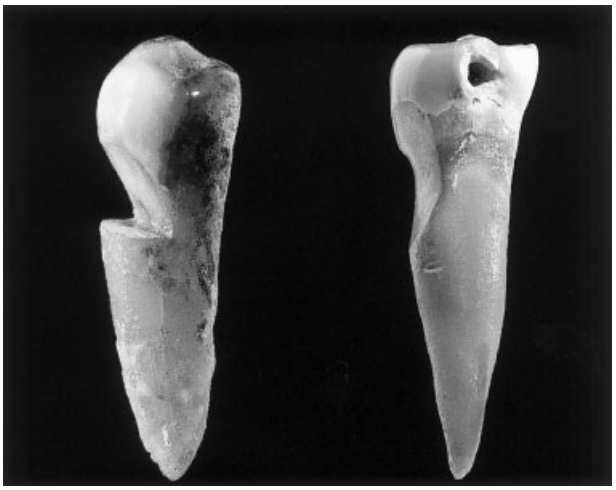

Fig. 1. Modern mandibular premolars presenting noncarious cervical tooth lesions (NCTL). Note very different appearance of NCTL in comparison with interproximal carious cavity.

The aim of this dental anthropological study was to determine if there has been a temporal variation in the prevalence of NCTL by comparing archaeological samples and subjects examined in contemporary dental practices. To our knowledge, there have been no recent studies on this topic. The only available information on the subject was provided by Miller (1907), who reported no NCTL in 6,000 skull specimens but gave no information on the origin of the specimens and included personal communications. In the present study, we systematically examined two series of samples to detect NCTL. The first series consisted of teeth in skeletal remains from the prehistoric (Copper Age) and Medieval period excavated at sites in southern France. The second series consisted of teeth of subjects examined in three dental practices in southern France.

MATERIALS AND METHODS

Archaeological sample series

Archaeological samples came from three sites located within the same 200-km perimeter in southern France, i.e., Roaix, Saint-Pierre de Almanarre, and Notre Dame du Bourg. Skeletal remains in the present study are archived in the Anthropology Laboratory of Marseille Medical School (Northern Sector, Mediterranean University). The dental arches were separate or in pairs from the same individual, intact or fragmented, and with or without antemortem or postmortem tooth loss. Remaining teeth were considered as evaluable if they were devoid of caries, postmortem alterations, or calculus masses in the cervical area. Whenever possible, sex and age were respectively determined by the method described by Ferembach et al. (1980) and by the cranial sutures and/or eruption status and attrition patterns in the molar teeth (Miles, 1962). In total, 3,927 remaining teeth in the dental arches of 259 individuals over age 12 years from the prehistoric (one sample set) and Medieval (two sample sets) periods were studied (Table 1).

The Roaix archaeological site (Bouville, 1980) is a mass grave containing the remains of Copper Age farmers buried in two sepulchral layers separated by a sterile one. Radiocarbon dating indicated that the lower layer dates from 2,150 ± 140 years BC (date ± 1 standard deviation) , and the upper level from 2,090 ± 140 years BC (Delibrias et al., 1971). We examined 85 dental arcades including 50 separate mandibles, 17 separate maxillae, and 9 paired maxillae (n = 9) and mandibles (n = 9) from 76 individuals (Table 1). Sex could not be determined for these individuals, but it can be supposed that the grave included both men and women, since a survey of 26 individuals for whom gender was determinable showed 14 men and 12 women. Age was 12–36 years in 41 cases, over 36 years in 17 cases, and unknown in 18 cases. In total, 856 of the 953 remaining teeth (89.8%) were considered evaluable (Table 1) using the aforesaid criteria.

The Saint-Pierre de l'Almanarre site (Mafart, 1996) is a cemetery located next to a Cistercian convent inhabited from the 12th–14th centuries AD. More than 350 skeletons of nuns and farmers were collected from the site. A survey of 100 individuals for whom gender was determinable showed 60 men and 40 women, thus confirming that the cemetery contained both sexes. We examined 148 dental arches, including 72 separate mandibles, 34 separate maxillae, and 21 paired maxillae (n = 21) and mandibles (n = 21) from 127 individuals (60 nuns and 67 farmers) (Table 1). Age was 12–36 years in 90 cases, over 36 years in 35 cases, and unknown in 2 cases. Of the 2,321 remaining teeth, 2,189 (94.3%) were considered evaluable.

The Notre-Dame du Bourg site (Demians d'Archimbaud, 1992) is a cemetery that was used between the 3rd–17th centuries. Only remains from the 14th century were studied (Table 1). In total, 63 dental arcades including 28 separate mandibles, 21 separate maxillae, and 7 paired maxillae (n = 7) and mandibles (n = 7) from 56 individuals were examined. Sex was male in 19 cases, female in 9, and undeterminable in 28. Of the 953 remaining teeth, 882 (92.5%) were considered evaluable.

Modern subject series

In total, 6,145 teeth in 238 dental patients from in three dental practices (samples 1–3) in southern France were examined (Table 1). Teeth were considered as evaluable if they were devoid of caries, fillings, or calculus in the cervical area. Subjects were of both sexes, and all ages over 12 years were included.

Study design

Dental examination was conducted by three examiners. Each observer examined one archaeological sample from one site and one patient cohort

TABLE 1. Archeological and modern subject samples used for comparison of NCTL prevalence in past and present populations

	Archeological series (series 1), 259 individuals; 3,927 teeth			Modern series (series 2), 238 individuals; 6,145 teeth		
Sample	Roaix[1]	Saint-Pierre de l'Almanarre[2]	Notre-Dame du Bourg[3]	Observer 3	Observer 2	Observer 1
Period	2150–2090 BC	1100–1300 AD	1300–1400 AD	Modern	Modern	Modern
Individuals	76	127	56	149	41	48
Teeth	856	2,189	882	3,877	950	1,318

[1] Observer 1.
[2] Observer 2.
[3] Observer 3.

TABLE 2. Prevalence of noncarious cervical tooth lesions (NCTL) in acheological samples and modern subjects according to number of individuals

	Archeological samples (series 1)				Modern subjects (series 2)		
Age group	Male	Female	Undetermined sex	Total	Male	Female	Total
12–36 years							
No. with lesion	0/9	0/47	0/101	0/157	12/107	9/26	21/133
%	0	0	0	0	11.2	34.6	15.8
>36 years							
No. with lesion	0/9	0/19	0/49	0/77	23/62	18/43	41/105
%	0	0	0	0	37.1	41.9	39
Undetermined age							
No. with lesion	0/1	0/3	0/21	0/25			
%	0	0	0	0			
Total							
No. with lesion	0/19	0/69	0/171	0/259	35/169	27/69	62/238
%	0	0	0	0	20.7	39.1	26.1

(Table 1). To assess intraobserver error, each observer examined 15 subjects from his/her cohort on two separate occasions, 1 month apart. To assess interobserver error, 6 individuals presenting lesions in one patient cohort were examined by all observers. Intraobserver and interobserver agreement for the diagnosis of NCTL was 100% in all cases.

In the archaeological series, diagnosis of NCTL was achieved by direct naked-eyed assessment with a dental probe under satisfactory lighting conditions. In addition to the location of lesion (buccal, lingual, or interproximal surface of the cemento-enamel junction), the type of tooth involved and number of lesions per tooth were noted. Prevalence of NCTL was calculated in terms of number of teeth examined as well as number of individuals, to account for the high number of incomplete dental arcades sets.

In the contemporary series, diagnosis of NCTL was carried out using a mouth mirror and a dental probe. Examination included the subgingival area. In addition to noting the number of individuals with lesions, the number of teeth examined in this series was recorded to allow correlation of lesion prevalence with the number of evaluable teeth, as in the archaeological samples series. Type of tooth involved, location of lesion (buccal, lingual, or interproximal surfaces), and number of lesions per tooth were noted.

Statistical analysis was performed using the chi-square and Fisher's exact tests, evaluated at the conventional level of alpha = 0.05.

RESULTS

In the modern series, a total of 277 NCTL was found in the 6,145 evaluable teeth for a prevalence rate of 4.5%, and 62 of the 238 individuals included in this study, i.e., 26%, presented at least one lesion. No NCTL were found in any of the 3,927 evaluable teeth from the 259 individuals in the archaeological sample series (Tables 2 and 3). The difference between the two series was highly significant, in terms of both teeth (0/3,927 vs. 277/6,145; chi-square test with Yates correction, 180.3 , $P < 10^{-7}$) and individuals (0/259 vs. 62/238; chi-square test with Yates correction, 74.7, $P < 10^{-7}$).

Sex and age may have had an influence in the modern series (Table 2). Prevalence of NCTL was significantly higher in women than in men, i.e., 27/69 (39.1%) vs. 35/169 (20.7%); (chi-square test with Yates correction, 7.7, $P = 0.006$). Similarly, prevalence was significantly higher in individuals over age 36 than in individuals between ages 12–36 years, i.e., 41/105 (39%) vs. 21/133 (15.8%) (chi-square test with Yates correction, 15.3, $P < 10^{-4}$).

The possibility that age was a confounding factor with regard to sex was studied. Stratified analysis demonstrated an interaction between these two factors. The risk of NCTL was 4.2 times higher for women in the 12–36-year age group (chi-square test with Yates correction, 6.94, $P < 0.01$), as compared to only 1.9 times higher for women than men in the over-36-year age group (chi-square test with Yates correction, 0.08, $P = 0.7$).

TABLE 3. Prevalence of noncarious cervical tooth lesions (NCTL) in acheological samples and modern subjects according to number of teeth

Tooth type	Archeological samples (series 1)			Modern subjects (series 2)		
	Maxillary	Mandibular	Total	Maxillary	Mandibular	Total
Molars						
No. with lesion	0/551	0/862	0/1,413	28/906	22/891	50/1,797
%	0	0	0	3.1	2.5	2.8
Premolars						
No. with lesion	0/472	0/580	0/1,052	71/896	62/889	133/1,780
%	0	0	0	7.9	7	5
Incisors/canines						
No. with lesion	0/690	0/772	0/1,462	55/1,258	39/1,305	94/2,563
%	0	0	0	4.4	3	3.7
Total						
No. with lesion	0/1,713	0/2,214	0/3,927	154/3,060	123/3,085	277/6140
%	0	0	0	5	4	4.5

Comparison between the archaeological sample and modern subject series was performed separately for the four sex and age subgroups, i.e., men between 12–36 years, women between 12–36 years, men over 36 years, and women over 36 years. The difference in NCTL prevalence between the 12–36-year subgroups in the archaeological series and modern subject series was not significant, i.e., 12/107 (11.2%) vs. 0/9 (0%) (Fisher's exact test, $P = 0.3$). This finding may be due to the small size of the archaeological sample group. For the other three subgroups, statistical analysis using the Fisher's exact test demonstrated that NCTL prevalence was always significantly lower in the acheological series, i.e., 0/47 vs. 9/26 for the 12–36 year female subgroup ($P < 10^{-4}$), 0/9 vs. 23/62 for the over-36-year male subgroup ($P = 0.02$), and 0/19 vs. 18/43 for the over-36-year female subgroup ($P = 0.002$).

Analysis of data related to tooth type (Table 3) showed that NCTL prevalence was significantly lower in the archaeological sample series than in the modern-subjects series for all subgroups, i.e., 0/1,413 vs. 50/1,797 for the molars (chi-square test with Yates correction, 38.14, $P < 10^{-8}$), 0/1,052 vs. 133/1,785 for the premolars (chi-square test with Yates correction, 80.58, $P < 10^{-8}$), 0/1,462 vs. 94/2,563 for the incisives/canines (chi-square test with Yates correction, 53.31, $P < 10^{-8}$). Within the modern individuals series, there was no significant difference in the involvement of mandibular and maxillary teeth. However, considerable variation with an overall significant difference was observed between tooth types (chi-square test with Yates correction, 52.55, $P = 10^{-9}$). The tooth type most commonly affected by NCTL was premolars (133/1,785; 7.5%), which showed a significant difference with both incisives/canines (94/2,563; 3.7%, chi-square test with Yates correction, 29.68, $P = 10^{-7}$) and molars (50/1797; 2.8%, chi-square test with Yates correction, 39.3, $P = 10^{-8}$). The difference between incisives/canines and molars was not significant (chi-square test with Yates correction, 2.32, $P \leq 0.05$).

Among the 277 NCTL observed in the modern series, 272 (i.e., 98%) were buccal with sometimes a mesial or distal extension, and 5 were mesial. No lesion was observed on the lingual surfaces. We never noted more than one lesion per tooth.

DISCUSSION

The main finding of the present study is the absence of NCTL in a large sample of teeth from prehistoric and Medieval skeletal remains in southern France. In comparison, the prevalence of NCTL in modern subjects in the same region was 4.5% (277/6,145).

The prevalence of NCTL in the three modern-subjects series was consistent with epidemiological data in the literature. Levitch et al. (1994) reported prevalence rates for all age groups varying from 2% (n = 1,345) to 85% (n = 250), depending on sampling and diagnostic techniques used. In a study involving 10,000 teeth extracted from dental patients, Sognnaes et al. (1972) found NCTL in 18% of cases. The higher prevalence in that study than in ours (18% vs. 4.5%, 277/6,145) could have been due to more extensive damage in extracted teeth. Our study confirms that NCTL are common in modern subjects. Results in our patient series suggest that the risk of NCTL in dental patients increases with age and is greater in women than men, and also that premolars are the most commonly affected tooth type.

The marked difference demonstrated in this study between NCTL prevalence in archaeological samples and in dental patients must be interpreted with caution. Prevalence in the archaeological series may have been underestimated due to missing data on age and sex and to postmortem tooth loss and damage. However, the validity of our results is supported by the size of our archaeological series, including 3,927 teeth from 259 individuals from three different archaeological sites and by the possibility that NCTL may also have been underestimated in dental patients due to difficulty in visualizing subgingival lesions.

Since comparison of hard dental-tissue microstructure of archaeological and modern teeth has not shown any difference that could explain the low prevalence rate of some dental diseases in past groups (Falin, 1961), the absence of NCTL could be

indicative of temporal variation in the causes of NCTL, i.e., toothbrushing, acid erosion, and tooth flexure. Changes in toothcleaning habits and amount of acid exposure are difficult to document in archaeological samples. The third mechanism involves occlusal stress due to abnormal cusp interference and forces applied outside the long axis of the tooth during mandibular movements. It has been speculated that long-term occlusal stress can lead to tooth flexure and may generate or aggravate NCTL. In our opinion, the results of this study could imply that conditions of occlusal stress were fundamentally different in the past. Teeth in our archaeological series may not have been submitted to sufficient levels of occlusal stress to induce tooth flexure and cause NCTL.

A noteworthy observation in our study was the presence of extensive wear of the occlusal surfaces of teeth in both the prehistoric and Medieval series. Cusp relief disappeared at an early age due to chewing of abrasive foodstuffs such as stone-ground cereals for prehistoric populations at Roaix (Courtin, 2000), and bread made months in advance from unrefined flour and coarse cereals and salt-cured meat and fish in the Medieval populations (Stouff, 1961). As a result of cusp disappearance, occlusal surfaces were flat, so that teeth could slide without interference in all directions during mandibular movement, thus reducing occlusal stress and the risk of NCTL. Since the modern diet does not include coarse foods, cusp relief remains and may generate higher lifetime levels of occlusal stress.

The findings described here should encourage further study of archaeological skeletal remains to determine if our samples are representative of the prehistoric and Medieval periods in general. It would also be interesting to study present-day populations switching from a traditional to Westernized lifestyle with regard to dental hygiene and diet, in order to better understand the influence of food consistency on development of NCTL.

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