Can Tooth Plaque Save Your Teeth?
Comparative Analysis of Carious Lesions (Cavities) and Dental Calculus

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Introduction

One of the most common approaches to studying populations in the past is through their teeth. Teeth contain information that allows us to address questions about diet and health, showing evidence of the surrounding environment in pathological indicators such as carious lesions (cavities) and calculus. Calculus is formed by the mineralization of dental plaque, the buildup of microbial communities on the tooth surface [1,2]. Dental caries is the progressive demineralization of the tooth due to the acid production of the bacteria in the mouth, often resulting in carious lesions in the enamel [2]; however, the increase of acid in the mouth also leads to the breakdown of plaque[4].

In this study, we documented the prevalence of carious lesions and calculus among the teeth of ancient inhabitants of the Santa Barbara Channel region. Our goals were threefold: 1) to build on previous research that showed prehistoric declines in the sexual differentiation and overall frequency of caries in this region, consistent with a dietary shift from terrestrial plants to marine animals, 2) to examine the relationship between dental caries and calculus formation in a pre-modern population, and 3) to assess the preservation of calculus in ancient human remains for microbiome research in the future.

Top: Occlusal view of mandible with calculus present on all teeth and two carious lesions on the left and right first molars.

Bottom: Lateral view of the two lower premolars and three molars covered with supragingival calculus, and a carious lesion on the first molar.

Methods and Sample

The study sample consisted of 174 skeletal individuals in the physical anthropology collection at the National Museum of Natural History. All the remains are from Santa Barbara County, CA and most likely date to the Late or Historic periods of the last 1,000 years. Visual assessments of teeth followed *The Human Bone Manual* by Tim D. White and Pieter A. Folkens and *Human Osteology* by William Bass as reference for calculus, caries, and tooth placement. Each tooth was recorded as present or absent and scored for carious lesions and calculus as present, absent, or unobservable. To control for variation in tooth preservation between individuals, we calculated the total percentage of carious and calcified teeth for the sample, combining right and left sides of the dentition by tooth and tooth type.

Carious lesions

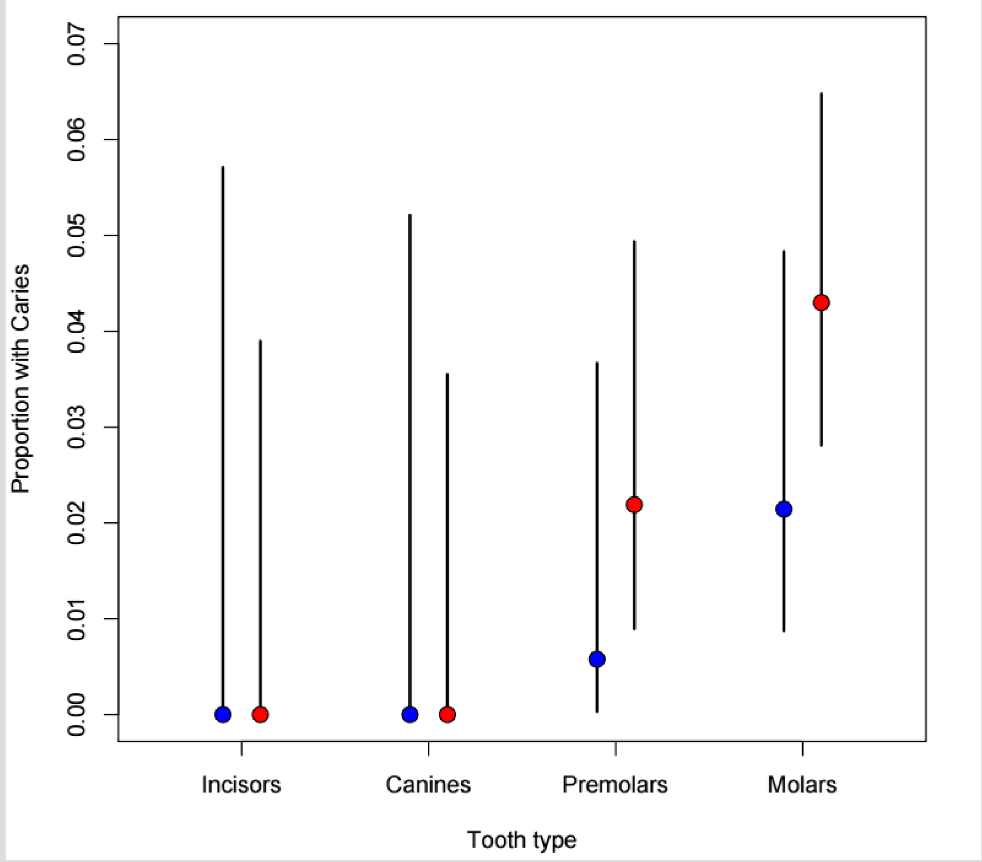

Figure 1. Proportions of teeth with carious lesions in females (red) and males (blue) by tooth type.

Top: Buccal carious lesion on the left mandibular second molar.
Bottom: Buccal and interproximal carious lesions on the left mandibular premolars and second molar.

Calculus

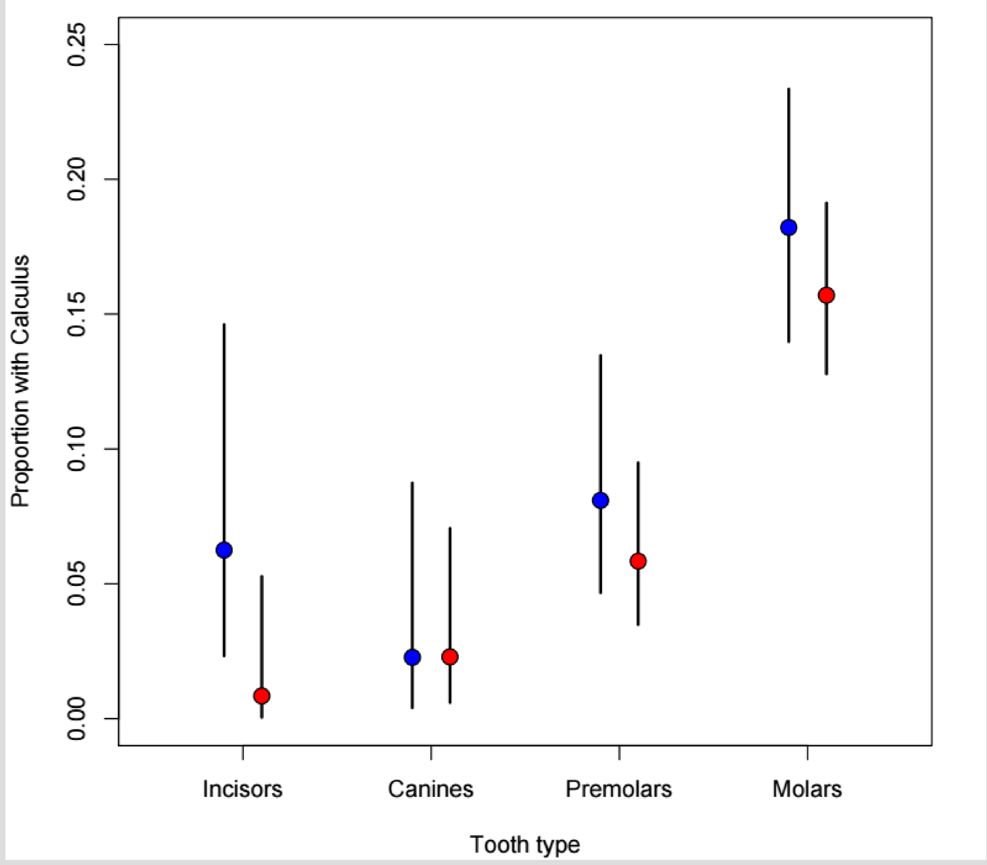

Figure 2. Proportions of teeth with calculus in females (red) and males (blue) by tooth type.

Top: Supragingival calculus on the right maxillary second molar.
Bottom: Subgingival calculus on the left maxillary second premolar.

Results and Discussion

The Santa Barbara County sample showed very low frequency of carious lesions as a whole (2.2%) (Table 1), which gives us insight into the increasing reliance of marine foods[6]. Carious lesions were more prevalent in the molars followed by the premolars, and none found in the canines or incisors (Fig. 1). There were no clear differences between men and women for caries (Fig. 1). Calculus was most prevalent in the molars, followed by the premolars, incisors, and then the canines (Table 2). Men had more calculus build up then women did, and both followed the same trend by tooth type (Fig. 2). However, carious lesions and calculus were not observed on the same teeth.

Based on archaeological evidence it appears that native people of the Santa Barbara Channel region developed more specialized fishing tools over time[5]. With the increase of trade between mainland and island populations, the amount of caries decreased with an increase of shellfish found in the archaeological sites[5,6]. Previous research on one of the Channels Islands of Santa Barbara County (Santa Rosa Island) showed a decrease in caries over time, from 17% to 7.7% of carious teeth in cemeteries dated to ca. 4,000 until 500 years ago, as well as a decrease in male and female frequencies[6]. Our results are consistent with these trends and support an interpretation of a relatively recent population with a dietary emphasis on non-cariogenic marine foods. Furthermore, our results show a negative correlation between caries and calculus in this sample, although more research is needed to evaluate the possible causal naturel of this relationship.

Table 1. Distribution of carious lesions in the study sample among teeth, by sex.

		Female				Male				Pooled Sex			
Bone	Tooth	N Total	N Present	% Present	95% CI	N Total	N Present	% Present	95% CI	N Total	N Present	% Present	95% CI
Maxilla	I1	28	0	0.0	0.0 - 15.0	12	0	0.0	0.0 - 30.1	40	0	0.0	0.0 - 10.9
	I2	29	0	0.0	0.0 - 14.6	24	0	0.0	0.0 - 17.2	53	0	0.0	0.0 - 8.4
	C	82	0	0.0	0.0 - 5.6	57	0	0.0	0.0 - 7.9	139	0	0.0	0.0 - 3.4
	P1	67	3	4.5	1.2 - 13.4	53	0	0.0	0.0 - 8.4	120	3	2.5	0.6 - 7.7
	P2	71	2	2.8	0.5 - 10.7	46	0	0.0	0.0 - 9.6	117	2	1.7	0.3 - 6.7
	M1	122	5	4.1	1.5 - 9.8	61	1	1.6	0.1 - 10.0	183	6	3.3	1.3 - 7.3
	M2	88	3	3.4	0.9 - 10.3	58	1	1.7	0.1 - 10.5	146	4	2.7	0.9 - 7.3
	M3	50	4	8.0	2.6 - 20.1	31	1	3.2	0.2 - 18.5	81	5	6.2	2.3 - 14.4
Mandible	I1	22	0	0.0	0.0 - 18.5	19	0	0.0	0.0 - 20.9	41	0	0.0	0.0 - 10.7
	I2	40	0	0.0	0.0 - 10.9	25	0	0.0	0.0 - 16.6	65	0	0.0	0.0 - 7.0
	C	49	0	0.0	0.0 - 9.1	31	0	0.0	0.0 - 13.7	80	0	0.0	0.0 - 5.7
	P1	63	0	0.0	0.0 - 7.2	39	1	2.6	0.1 - 15.1	102	1	1.0	0.1 - 6.1
	P2	73	1	1.4	0.1 - 8.4	35	0	0.0	0.0 - 12.3	108	1	0.9	0.0 - 5.8
	M1	100	6	6.0	2.5 - 13.1	43	0	0.0	0.0 - 10.2	143	6	4.2	1.7 - 9.3
	M2	94	4	4.3	1.4 - 11.2	45	0	0.0	0.0 - 9.8	139	4	2.9	0.9 - 7.7
	M3	81	1	1.2	0.1 - 7.6	42	3	7.1	1.9 - 20.6	123	4	3.3	1.0 - 8.6
All teeth		1059	29	2.7		621	7	1.1		1639	36	2.2	

Table 2. Distribution of calculus in the study sample among teeth, by sex.

		Female				Male				Pooled Sex			
Bone	Tooth	N Total	N Present	% Present	95% CI	N Total	N Present	% Present	95% CI	N Total	N Present	% Present	95% CI
Maxilla	I1	50	5	10.0	0.0 - 15.0	12	1	8.3	6.1 - 34.5	40	1	2.5	0.1 - 14.7
	I2	88	11	12.5	0.2 - 19.6	24	2	8.3	10.3 - 31.8	53	3	5.7	1.5 - 16.6
	C	122	25	20.5	0.4 - 9.4	57	2	3.5	14.8 - 37.6	139	4	2.9	0.9 - 7.7
	P1	71	6	8.5	0.1 - 9.1	53	2	3.8	6.8 - 29.5	120	3	2.5	0.6 - 7.7
	P2	67	1	1.5	3.5 - 18.1	46	7	15.2	0.7 - 14.1	117	13	11.1	6.3 - 18.6
	M1	82	2	2.4	13.9 - 28.9	61	15	24.6	0.6 - 13.2	183	40	21.9	16.2 - 28.7
	M2	29	1	3.4	6.7 - 21.7	58	11	19.0	1.5 - 28.5	146	22	15.1	9.9 - 22.1
	M3	28	0	0.0	3.7 - 22.6	31	5	16.1	0.4 - 40.2	81	10	12.3	6.4 - 22.0
Mandible	I1	22	0	0.0	0 - 18.5	19	0	0.0	4.5 - 26.4	41	0	0.0	0 - 10.7
	I2	40	0	0.0	0.0 - 10.9	25	2	8.0	8.5 - 32.6	65	2	3.1	0.5 - 11.6
	C	49	1	2.0	0.1 - 12.2	31	0	0.0	7.3 - 31.3	80	1	1.3	0.1 - 7.7
	P1	63	3	4.8	1.2 - 14.2	39	4	10.3	0.1 - 16.6	102	7	6.9	3 - 14.1
	P2	73	6	8.2	3.4 - 17.6	35	1	2.9	3.3 - 25.2	108	7	6.5	2.9 - 13.4
	M1	100	14	14.0	8.1 - 22.7	43	7	16.3	0.0 - 13.7	143	21	14.7	9.5 - 21.8
	M2	94	16	17.0	10.3 - 26.5	45	8	17.8	1.4 - 27.5	139	24	17.3	11.6 - 24.8
	M3	81	13	16.0	9.2 - 26.2	42	5	11.9	0.0 - 20.9	123	18	14.6	9.1 - 22.4
All teeth		1059	104	9.8		621	72	11.6		1639	176	10.7	

Future Research

There are several theories on the relationship between calculus and other pathologies found within the mouth. One being that the amount of calculus has a direct effect on other oral diseases, meaning the more calculus an individual has, the more likely he or she is to develop another pathology[1]. Another theory is the type of microflora rather than the amount lead to other pathologies[1]. This study analyzes if there is a relationship between caries and calculus through visual analyses. Future studies can look at the calculus and analyze the microbiomes at the cellular level and compare them to visual data collected to make connections as to what microflora lead to which pathologies.

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