



**U. S. NAVAL SUBMARINE
MEDICAL CENTER**

Submarine Base, Groton, Conn.

REPORT NUMBER 512

LONGITUDINAL STUDY OF DENTAL CALCULUS IN HUMANS
IN ANTARCTIC

by

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Bureau of Medicine and Surgery, Navy Department
Research Work Unit MR005.19-6025 17

Released by:

Gerald J. Duffner, CAPT MC USN
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23 February 1968



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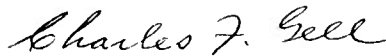
SUBMARINE MEDICAL RESEARCH LABORATORY
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SUMMARY PAGE

THE PROBLEM

The control of periodontal disease in naval personnel requires an understanding of the related factors. The dental calculus formation rate has long been of interest in this regard but methods of measuring this parameter have not been fully evaluated in the Navy. Precise reproducible methods for measuring calculus formation rates are required.

FINDINGS

Evaluation of two methods of calculus formation rate measurements, the standardized foil technique and the Volpe-Manhold direct measurement technique, indicates that each of these are highly useful tools in navy preventive dentistry and environmental dentistry studies. Each method is highly reproducible on a longitudinal study basis.

APPLICATIONS

Either of the two methods of assessing dental calculus formation rates will be of value in Navy preventive dentistry studies. Each method complements the other and the one to be used will depend upon the duration and the design of the study.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MR005 19-6025—Study of Oral Health in the Antarctic. This report has been designated as No. 17 on this Work Unit, and was approved for publication on 23 February 1968 as Report No. 512. Sixteen previous reports have been published under MR005 12-5220 02 and MF022 03 03-9002.

PUBLISHED BY THE NAVAL SUBMARINE MEDICAL CENTER

A LONGITUDINAL STUDY OF DENTAL CALCULUS FORMATION IN HUMANS IN THE ANTARCTIC

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The role of dental calculus in the etiology and progress of periodontal disease has been of long interest, even though the precise relationships remain unclear. The high incidence of periodontal disease in the United States Navy^{1,2} has caused a large amount of effort to be directed toward the problem of dental calculus formation rates.

One of the major problems in studying calculus formation rates in military groups has been that of a suitable scoring method for necessarily short term studies. Such a method is particularly required for evaluating effects of preventive dentistry techniques and for evaluating environmental effects on calculus formation. Two methods in current use seemed promising for meeting the requirements of such small group longitudinal studies. The Volpe-Manhold method³ and the standardized foil technique⁴. The former method employs the direct measurement of calculus, in all planes, on the lingual surface of the mandibular incisor and canine teeth. The standardized foil technique consists of attaching polyester foils to the lingual surface of the mandibular central incisors for a period of seven days and analyzing the calculus collected. To evaluate the applicability of these methods to the Navy's small group testing needs, a study was designed to assess the reproducibility of the two methods between test periods and to assess the comparability of the methods during the same time period.

The Antarctic seemed a suitable location for such a study because of the uniform diet and static population throughout the study period. The test was conducted at McMurdo Sound, the Navy's main Operation Deep Freeze base, during Austral winter, 1967. The men located at McMurdo during this period are in complete isolation for seven months. Thus, there is little possibility of dietary or environmental variability.

Materials and Methods

Fifteen volunteers were selected for study from the wintering-over crew of Antarctic Support Activity. Four men dropped out of the study prior to its initiation because of previous commitments, which would have interfered with the study. Eleven subjects were retained.

The standardized foil technique was utilized to collect the calculus. This technique employs triangular foils punched from polyester sheets* 0.051 mm, in thickness, with a standardized surface area of 29 mm². The foils are sandblasted to provide a uniformly roughened surface for the deposition of calculus. The foils were attached to the mandibular central incisors by means of dental floss. The men were instructed not to brush their teeth in the area of the foils, and to return in seven days for their removal. At the end of the seven day period the foils were removed, and air dried. They were stored in individual vials marked with the date, subject name and group. The lower six anterior teeth were then scaled and a prophylaxis was performed to remove all deposits. The subjects were instructed to return in three months for calculus measurements.

At the end of the first three month period, the patients were recalled. The six mandibular anterior teeth were dried with a warm air syringe for a period of one minute. A standard periodontal probe was employed to measure the depth of the calculus from its most inferior point to the most superior point as described by Volpe and co-workers³. Three points on each tooth were measured. The probe was placed so that it bisected the lingual surface of the tooth, the second position was located diagonally through the mesioincisal angle of the tooth, the third, diagonally through the disto-incisal angle.

The largest of the three measurements was recorded on mimeographed sheets which contained a drawing of the lingual surfaces of the six anterior teeth. In addition, the position and the height of the calculus, in mm, were depicted as drawings on the score

*MYLAR DuPont/TYP A 200

sheet A total score was recorded for each subject by adding the maximum score of calculus recorded for each of the six teeth for the individual

The teeth were again scaled and a prophylaxis accomplished on the six teeth The Mylar foils were again placed on the mandibular centrals At the end of the seven day period the foils were removed, stored, and a prophylaxis accomplished The subjects were instructed to return in three months At the end of this period the measurements were repeated as described above The foils were then reattached for one more collection period

In summary, the subjects wore the foils for three seven day test periods, three months apart The Volpe-Manhold measurements were taken at the second and third test periods, also three months apart

Upon return to the Submarine Medical Research Laboratory, Groton, Connecticut, the foil analyses were completed The foils were weighed on a Cahn microelectrobalance to obtain the dry weight They were then ashed in platinum crucibles at 900 degrees C for 30 minutes and reweighed to obtain the ash weight The ash was dissolved in 50 ml of 3N HCl After all ash had dissolved the solution was diluted with deionized water Calcium was determined by the micro method of Diehl and Ellingboe⁵ and the phosphorus by a micro adaptation method of Fiske and Subbarow⁶

Results

The analyses of the standardized foils are given in Table 1 The differences between the test period means are not significant It is noted that the calcium phosphorus ratios are rather low This probably resulted from the presence of relatively large amounts of organic phosphorus

Table 2
Ash Weight Correlations.

Exam Period	1st	2nd	3rd
1st	—	+ 68*	+ 65
2nd	+ 68	—	+ 83
3rd	+ 65	+ 83	—

*Spearman rank correlation coefficient

When examining the ashed weight correlations between the three foil test groups (Table 2), a significant correlation coefficient of + 83 was noted between test periods two and three ($P < 01$) All other correlations between ash weights were of borderline significance ($P < 05$) All measurements of dry weights between test groups proved to have only a weak correlation ($P < 05$) When comparing the Volpe-Manhold method with the standardized foil technique no significant correlation was noted between groups, with the exception of borderline significance for correlations between the two methods at the first examination period

The analysis of the Volpe-Manhold method, between test periods, is given in Table 3 The differences between the mean scores of

Table 1
Analysis of Standardized Foil Deposits

	N	Dry weight* foil + calculus	Ash weight	P	Ca	Ca/P, w/w
Period I	11	3953 60** ±198 0***	1280 ±170	57 05 ±11 85	84 55 ±15 70	1 36 ± 11
Period II	11	3950 90 ±188 00	1020 ±230	69 50 ±10 02	83 62 ±13 15	1 23 ± 13
Period III	11	3853 50 ±132 00	890 ±230	54 76 ±10 34	81 91 ±15 70	1 35 ± 16

*All weights in ugm

**Mean

***Standard error of mean

4.59 and 3.83 were not statistically significant. Evaluation of the method indicated a high degree of reproducibility between test periods for each individual. Rank correlation analysis yielded an r_s value of +.88. Comparison of individual teeth measurements between the two test periods revealed the same scores in 47% of the teeth and scores within .5 of each other in 91% of the cases.

Table 3

Calculus measurements by the Volpe-Manhold Method

Test Period	N	Mean score	Correlation period 1 vs 2
1	11	4.59 ± 1.08 +	+ .88
2	11	3.83 ± .92	

*Spearman rank correlation coefficient

+Standard error of the mean

Discussion and Conclusion

Both methods appear to be reproducible, as evidenced by the degree of correlation within each method. Each method tends to have merit, depending on the objectives sought, however, the two methods are probably not interchangeable, as evidenced by the low degree of correlation between them. Each method has specific advantages inherent in the technique. The advantages of the standardized foil technique are the relatively short collection periods, the precipitation of calculus relatively free of tooth surface ions which is of value when analyzing calculus components, and the standard collection surface between subjects. The disadvantages observed by this investigator were the difficulty in placement of the foils and some discomfort to the subject. In addition, there is some question as to the applicability of this unnatural surface for a collection system.

The Volpe-Manhold method is more acceptable than the foil method to the subject. There is greater facility of measurement and the calculus being measured is in a "natural" state. The disadvantages to the Volpe-Manhold method are the relatively long collection times and the difficulty in obtaining meaningful samples for analysis. The latter problem was not a factor in this study, however, a test is in progress, at present, at McMurdo dealing specifically with this problem.

The environmental aspects of this study merit some mention. Past studies have indicated the possibility of oral changes due to the Antarctic environment, particularly with regard to the bacterial plaque.^{7,8} When comparing the means between the test periods (derived by both methods) no significant differences were found, however, by each method a slight reduction in the calculus formation rate was seen as the Antarctic isolation progressed. No practical importance can be attached to these slight changes at this time.

Summary

1. The calculus measurement method described by Volpe and Manhold was compared with the standardized foil technique for the purpose of assessing calculus formation rates in the Antarctic.

2. It was found that both methods have merit and are reproducible but apparently are not interchangeable.

3. No definite environmental effects on the calculus formation rate was noted in the Antarctic.

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DOCUMENT CONTROL DATA - R & D		
<i>(Security classification of title body of abstract and indexing annotation must be entered when the overall report is classified)</i>		
1 ORIGINATING ACTIVITY (Corporate author) U.S. NAVAL SUBMARINE MEDICAL CENTER, Submarine Medical Research Laboratory		2a REPORT SECURITY CLASSIFICATION UNCLASSIFIED
		2b GROUP
3 REPORT TITLE LONGITUDINAL STUDY OF DENTAL CALCULUS IN HUMANS IN ANTARCTIC		
4 DESCRIPTIVE NOTES (Type of report and inclusive dates) Interim report		
5 AUTHOR(S) (First name, middle initial last name) Stuart C. GOULD, LT DC USN, and William R. SHILLER, CDR DC USN		
6 REPORT DATE 23 February 1968	7a TOTAL NO OF PAGES 6	7b NO OF REFS 8
8a CONTRACT OR GRANT NO	9a ORIGINATOR'S REPORT NUMBER(S) Submarine Medical Research Laboratory Report No. 512	
b PROJECT NO MR005.19-6025.17		
c	9b OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
d		
10 DISTRIBUTION STATEMENT This document has been approved for public release and sale; its distribution is unlimited.		
11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY U.S. Naval Submarine Medical Center Box 600, Naval Submarine Base New London Groton, Connecticut 06340	
13 ABSTRACT The high incidence of periodontal disease in Naval personnel has focused much attention on dental calculus as one of the causative factors. The study of formation rates of calculus in military groups has been difficult because of the necessarily short terms of these studies. Two current assessment methods seemed promising for such studies: (1) A method involving the collection of calculus on a standard Mylar foil attached to the lower front teeth for seven days and (2) A method involving direct measurements of the calculus collected on the lower front teeth in a three month period. A study was conducted in the wintering-over group in the Antarctic to assess and compare these two methods. Each method has great usefulness to the Navy calculus studies as evidenced by a high degree of reproductibility in the same individuals at different periods of time.		

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Periodontal disease Dental calculus Antarctic climate - effect on periodontal disease						