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Correlation of Dental Calculus Weights with Volpe Manhold Index Scores

by

A. BAUMHAMMERS*

L. P. CANCRO**

M. PADER**

J. D. JUSTICE**

S. M. BOLTON**

SEVERAL INDICES HAVE BEEN PROPOSED to assess dental calculus, in order to study its development, inhibition and epidemiology. This subject has been reviewed recently [1] and all of the indices measure calculus deposits in two dimensions only and thickness is not considered. Prominent among these indices are those of Greene and Vermillion,[2] Ramfjord,[3] Ennever, Sturzenberger and Radicke,[4] and Volpe and Manhold.[5] Sharawy et al.,[6] however, have demonstrated a high correlation (correlation coefficient = 0.94) between calculus dry weight and the Volpe-Manhold Index (V-M Index).

The purposes of the current investigation were: (1) to confirm the correlation between supragingival calculus dry weight and the V-M Index reported by Sharawy et al., (2) to determine whether this correlation prevails using different dentifrices, (3) to establish whether calculus ash weight correlates with the V-M Index as well as the calculus dry weight did and (4) to derive a mathematical relationship between V-M Index and calculus dry weight.

METHODS AND MATERIALS

Thirty-eight subjects having relatively intact dentitions were selected on the basis of demonstrated ability to form measureable amounts of calculus. Measurements of supragingival calculus using the V-M Index were made at three points in time: Stage I, when the subject was selected for the study; Stage II, 100 days later, after use of a non-therapeutic dentifrice containing dicalcium phosphate dihydrate as the abrasive agent; and Stage III, an additional 100 days later, after use of a non-therapeutic dentifrice containing a silica xerogel as the abrasive agent. The subjects were provided a multituft medium-textured nylon toothbrush at Stages I and II. No attempt was made to alter the subjects' usual oral hygiene habits.

At each stage, supragingival calculus was scored using the V-M Index.[7, 8] A graduated periodontal probe was employed, and measurements were taken (in millimeters) on the lingual surfaces of the six lower anterior teeth in the following planes:

1. Bisecting the center of the surface.

2. Diagonally through the mesial-incisal or mesio-occlusal point angle of the tooth through the area of greatest calculus height.

3. Diagonally through the distal-incisal or distal-occlusal point angle of the tooth through the area of greatest calculus height.[7, 8]

The distances measured (18 measurements per subject) were totalled, and represented the V-M Index for each subject. Following these measurements, the calculus was carefully removed with scalers and curettes and harvested. Dry weights and ash weights were determined and residues were assayed for calcium and phosphorous by atomic absorption spectrophotometric procedures.

RESULTS

Of the 38 subjects participating in this study, 32 completed all three stages of the trial. The initial sex distribution was 27 males and 11 females, who ranged between 23 and 65 years. The mean age of the group was 35.7 years.

Table 1 presents the data on V-M Index and dried and ashed calculus weights. They were analyzed using a Pearson correlation analysis. The correlations between V-M scores and both dried and ashed calculus weights were highly significant ($p < .01$). The average V-M indices decreased from 11.6 in Stage I to 7.6 in Stage II; to 6.8 in Stage III. Decreases in calculus dry weight and ash weight were also observed. The average dry weight dropped from 12.9 mg to 4.2 mg and the average ash weight from 9.1 mg to 2.6 mg. These decreases, of course, have no significance in terms of "treatment effects," since the order of presentation was not balanced.

Table 2 presents the ratios of calcium to phosphorous in the calculus deposits at each stage of the investigation. There was no significant change in the quantitative

*Professor and Chairman, School of Dental Medicine, Department of Periodontics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213.

**Research and Development Division, Lever Brothers Company, 45 River Road, Edgewater, New Jersey 07020.

TABLE 1.
Correlation of V-M Index With Calculus Dry Weight and Calculus Ash Weight

	V-M Index			*Dried Calculus Weight (mg)*			*Ashed Calculus Weight (mg)*		
	Stage I	*Stage II*	*Stage III*	*Stage I*	*Stage II*	*Stage III*	*Stage I*	*Stage II*	*Stage III*
No. of subjects	38	36	32	38	36	32	38	36	32
Average	11.6	7.6	6.8	12.9	4.8	4.2	9.1	3.1	2.6
Range	4.5-30.5	1.5-20.5	0.5-19.0	3.1-66.2	0.5-16.0	0.4-15.3	1.7-46.1	0.2-11.3	0.1-9.7
Standard deviation of mean	1.1	0.7	0.7	2.1	0.6	0.6	1.5	0.4	0.4
Correlation coefficient (V-M Index vs. weight)				0.86	0.83	0.82	0.89	0.82	0.80

TABLE 2.
Calcium to Phosphorous Ca/P Ratio for Three Test Stages

	Ca/P		
	Stage I	*Stage II*	*Stage III*
Number of subjects	38	36	32
Average	1.75	1.73	1.74
Range	1.34-2.06	1.31-2.19	1.43-2.03
Standard deviation of mean	0.024	0.033	0.023

relation of the mineral components of the calculus during the course of the experiment.

The relationship of the V-M Index to supragingival calculus weight was examined. Since the V-M Index is the sum of several observations on a linear scale, the assumption was made that calculus weight could be related to the V-M Index raised to some appropriate power. A simple relation would be: dry calculus weight $= k$ (V-M Index),[3] where k is an appropriate constant. This assumes that the density of the calculus is more or less constant and that the V-M Index effectively measures a characteristic linear dimension of the three dimensional calculus deposit. Obviously, however, variation of calculus weight with V-M Index cannot simply be assumed to follow a simple third power law, since the nature of the relationship depends on the characteristics of the process by which calculus increases in weight and dimensions. Since these characteristics have not been clearly defined by appropriate studies, one must make certain assumptions in order to establish a relation between weight and V-M Index. It is reasonable that the exponent, b, in the relationship weight $= k$ (V-M Index),[b] varies between one and three. A least squares fit of log weight versus log V-M Index shows this exponent to be 1.47 with 95% confidence limits of 1.3 to 1.7.

DISCUSSION AND CONCLUSIONS

The high correlation between calculus weight and V-M Index previously observed [6] was confirmed in these experiments. In two separate series of measurements, taken 100 days apart and using dentifrices of different composition, correlations of dry calculus weight with V-M Index ranged from 0.82 to 0.86. A similar high correlation was found when ashed calculus weight was considered, viz. 0.80 to 0.89. The correlation did not appear to be influenced appreciably by the quantity of calculus found in the subjects; it remained high despite a large difference in amount of calculus present at the first measurement and the second and third measurements (taken after the subjects had been placed on different dentifrices for limited periods).

Comparison of the data obtained at Stages II and III indicates that the nature of the dentifrice used, i.e., one whose abrasive was chemically related to the mineral composition of calculus vs. one which was free of all sources of calcium and phosphate, did not alter either the correlation between dry weight or ash weight of calculus and V-M Index or the ratio of Ca to P in the calculus. The highly significant correlations reported here strongly support the V-M Index as a reliable clinical measure which accurately reflects calculus accumulation.

Using the data obtained in this study, a mathematical relation was derived between dry calculus weight and V-M Index: dry calculus weight $= k$ (V-M Index).[1.47]

Although no causal effects are implied by the empirical equation derived from the data, the equation could be used to estimate changes in average calculus weight from changes in V-M Index. For example, in a comparison of two products, a calculus-inhibiting product and a control, one could estimate the ratio of the average

weight of calculus in the two subject populations from V-M Index measurements as follows:

$$\frac{\text{calculus weight on test product}}{\text{calculus weight on control}} = \left[\frac{\text{(V-M Index) on test product}}{\text{(V-M Index) on control}}\right]^{1.47}$$

The validity of the proposed model for the direct estimation of calculus weight from V-M Index must be tested by additional studies.

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Abstracts

Immune Response To Clostridial Collagenase In Gingiva and Other Tissues of the Rabbit

Kraus, F. W., Mestecky, J., and Grupe, H. E., Jr.
J. Dent. Res., 51:293, 1972

Serologic, histologic, and immunohistochemical techniques were applied to 14 rabbits to detect the capabilities of bacterial collagenase to penetrate into gingival connective tissue and to stimulate production of specific antibodies. The experimental rabbits were divided into three groups and treated for six weeks as follows: Group 1 received topical applications of concentrated native collagenase into the gingival sulcus; Group 2 received local injections of denatured collagenase into attached gingiva; and Group 3 received systemic immunizations with collagenase in Freund's adjuvant. A fourth group served as the control. The presence of circulating antibodies in gingiva was demonstrated, with an Arthus reaction developing within an hour after antigenic intragingival challenge. Examination 24 hours after death showed gingival congestion with thrombosis of many smaller vessels, and partial thrombosis of some larger vessels. In the connective tissue polymorphonuclear leukocytes occurred in and around vessels and in small groups or strands. Perivascular eosinophils were seen; lymphocytes, plasma cells, macrophages, and eosinophils were seen scattered throughout the connective tissue. Rabbits not given concomitant intragingival injections did not demonstrate specific fluorescence in the gingiva or cervical lymph nodes. Group 1 rabbits receiving multiple sulcular applications of collagenase did not develop demonstrable serum antibodies which showed that bacterial collagenase did not penetrate the intact sulcular lining of the rabbit. Group 2 rabbits given multiple intragingival injections of denatured collagen only showed no detectable serum antibodies, but this group and Group 3 rabbits, challenged repeatedly, showed cells containing specific antibody in gingiva, with fluorescence demonstrated in plasma cells, vessel walls, and basement membranes. Those antibodies were of the IgG class of immunoglobulins, and it was concluded that the immune complex was probably responsible for the inflammatory process characterized by local eosinophilia. *Department of Microbiology and Periodontology, and Institute of Dental Research, University of Alabama in Birmingham, Birmingham, Alabama 35233.*

Lack of Relationship Between the Degree of Induced Gingival Hyperplasia and the Concentration of Diphenylhydantoin In Various Tissues of Ferrets

Steinberg, A. D., Alvarez, J., and Jeffay, H.
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Seven ferrets fed 40 mg. DPM (diphenylhydantoin)/kg. body weight per day for 17 weeks were studied for concentration of DPH in various body tissues. After 16 weeks, one of the DPH-treated ferrets was fed 150 mg. DPH/kg. body weight per day until it died seven days later. The DPH-induced lesions appeared clinically similar to the gingival reaction seen in humans; initial lesions were observed at six weeks around the maxillary carnassial teeth. No relationship was found between the degree of gingival hyperplasia and the concentration of DPH in the gingiva and other tissue of the ferrets; however, the small amount of gingiva necessitated including assessment of DPH in normal as well as hyperplastic tissue in the ferrets and possibly contributed to the negative correlation. No significant effect on protein synthesis was noted when studied by observation of differences in H^3 proline uptake and turnover in DPH-fed animals versus controls. It was suggested that the effects of DPH in the gingiva and those in wound healing may be quite different events with incomparable methods of action. A significant correlation was noted between the amounts of DPH in oral mucosa and the salivary glands, and it was suggested that the close contact of the labial gingiva with the oral mucosa (and its associated mucous glands) and the major salivary glands may contribute to the pattern of gingival hyperplasia in man. *Department of Periodontics, College of Dentistry, University of Illinois Medical Center, Chicago, Illinois 60612.*