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PERIODONTAL PATHOSIS IN MAN: XVI. EFFECT OF GLUCOSE DRINKS UPON SULCUS DEPTH

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INTRODUCTION

In 1962[1] a study was released showing a significant *decrease* in mean sulcus depth scores following the administration of a three-day, relatively low refined-carbohydrate—high-protein diet. However, the study provided no control group or dietary supervision, and two variables (refined-carbohydrate and protein) were operative. A second report appeared in 1965[2] showing *deepening* of the mean sulcus depth after a three-day sucrose regime versus no supplementation.

The present report is designed to summarize the early findings and to pursue the subject through a study of the sulcus depth effects of glucose versus placebo supplementation.

METHODS AND RESULTS

One hundred and eighteen presumably healthy dental students participated in this experiment. Forty subjects (diet group), as previously described,[1] were instructed to consume a relatively low refined-carbohydrate—high-protein diet. Thirty-six of the students were divided so that 22 were supplied with sucrose drinks (sucrose group); 14 served as controls (control group). Of the remaining 42, 21 (glucose group) were given glucose solutions; 21 (placebo group) were administered a low-calorie drink (prepared with artificial sweeteners).

Sulcus depth was measured with a Starlite periodontal probe to the nearest millimeter on the buccal, lingual, mesial and distal of the lower central and lateral incisors, and a mean sulcus depth score (expressed in millimeters to the first decimal) was derived for each individual.

At the initial visit, on Monday of the week, sulcus depth was measured. The 40 subjects in the diet group were instructed to consume a relatively low refined-carbohydrate—high-protein diet. There was no attempt to supervise the regimen. Thirty-six other students were randomly divided, 22 of whom were supplied with a sucrose supplement containing 100 grams of sucrose (C.P.), administered in solution daily beginning Monday afternoon and ending Friday morning. Each subject received a 50-gram drink at 7:45 A.M. and at 1:15 P.M. The remaining 14 subjects served as controls. The rest of the students (42) were divided equally. Twenty-one individuals (glucose group) were provided with a 225-gram glucose supplement daily for the three days, each receiving a 75-gram glucose drink at 7:45 A.M., at 9:45 A.M., and 1:15 P.M. The remaining 21 individuals (placebo group) were administered, at the same time intervals, a low-calorie artificially sweetened supplement.

Each subject was recalled on Friday of the same week, at which time sulcus depth was remeasured by the same examiner. Neither the examiner nor the student was aware of the nature of the supplement or the earlier findings.

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Table I provides the raw data for the diet group. Included are the case numbers, the initial and final mean sulcus depth scores, and the differences. Also shown are the means, standard deviations, and mean percentage change. Finally, there is a qualitative statistical analysis of the initial versus the difference from the initial visit. It will be observed that the 13 per cent decrease in sulcus depth is statistically significant ($P < 0.001$). Also shown (Table I) are the numbers of individuals demonstrating an increase, no change, and decrease in mean sulcus depth during the four-day experimental period. It can be seen that 85 per cent of the 40 subjects demonstrated mean sulcus depth scores at the final grading which were lower than those at the initial examination.

Table II summarizes, in like fashion, the data and results for the sucrose and the control groups. Attention is directed to the fact that there is a 5 per cent increase in mean sulcus depth scores in the sucrose group on a qualitative basis and that this change is statistically significant ($P < 0.001$). In contrast, the control group, receiving no supplement, showed a 1 per cent change which is not statistically significant ($P > 0.5$). The data are also viewed quantitatively. Seventy-three per cent of the sucrose-supplemented

TABLE 1

Sulcus depth patterns following a relatively low refined-carbohydrate—high-protein diet

Case number	Initial mean scores	Final mean scores	Difference	Case number	Initial mean scores	Final mean scores	Difference
032	2.3	2.4	+0.1	004	2.2	1.9	−0.3
006	1.8	1.8	0.0	005	1.9	1.6	−0.3
019	1.9	1.9	0.0	016	2.2	1.9	−0.3
030	2.2	2.2	0.0	020	1.8	1.5	−0.3
036	1.9	1.9	0.0	024	2.1	1.8	−0.3
036	1.8	1.8	0.0	040	2.4	2.1	−0.3
013	2.0	1.9	−0.1	009	2.3	1.9	−0.4
023	2.0	1.9	−0.1	034	2.2	1.8	−0.4
025	2.1	2.0	−0.1	035	2.3	1.9	−0.4
026	2.0	1.9	−0.1	037	2.3	1.9	−0.4
028	1.8	1.7	−0.1	038	2.8	2.4	−0.4
029	2.3	2.2	−0.1	001	2.1	1.6	−0.5
010	2.1	1.9	−0.2	003	2.2	1.7	−0.5
011	2.1	1.9	−0.2	008	2.1	1.6	−0.5
014	2.1	1.9	−0.2	012	2.4	1.9	−0.5
015	2.1	1.9	−0.2	017	2.3	1.8	−0.5
021	1.9	1.7	−0.2	027	2.3	1.8	−0.5
022	2.2	2.0	−0.2	031	2.1	1.6	−0.5
033	2.5	2.3	−0.2	007	2.3	1.7	−0.6
002	1.8	1.5	−0.3	018	2.3	1.7	−0.6

	Initial	Final	Difference
Means	2.14	1.87	−0.27
Standard deviations	0.22	0.22	
Percentage changes		−13%	
P		<0.001*	
Increase		1 (3%)	
No Change		5 (13%)	
Decrease		34 (85%)	
Total		40 (100%)**	

* Statistically significant

** Approximate

TABLE 2

Sulcus depth patterns with sucrose versus no supplementation

Case number	Sucrose initial mean scores	Group final mean scores	Difference	Case number	Control initial mean scores	Group final mean scores	Difference
3292	1.9	2.3	+0.4	3309	2.3	2.6	+0.3
3297	2.2	2.6	+0.4	3296	2.0	2.2	+0.2
3312	2.2	2.5	+0.3	3305	2.1	2.3	+0.2
3288	2.2	2.4	+0.2	3300	2.3	2.4	+0.1
3289	2.2	2.4	+0.2	3290	2.1	2.1	0.0
3294	2.2	2.4	+0.2	3298	2.1	2.1	0.0
3310	1.9	2.1	+0.2	3301	2.1	2.1	0.0
3295	2.1	2.2	+0.1	3307	2.1	2.1	0.0
3299	2.4	2.5	+0.1	3308	2.6	2.6	0.0
3302	2.8	2.9	+0.1	3319	2.1	2.1	0.0
3303	2.3	2.4	+0.1	3323	2.3	2.3	0.0
3311	2.0	2.1	+0.1	3306	2.5	2.4	−0.1
3316	2.3	2.4	+0.1	3321	2.4	2.3	−0.1
3317	2.0	2.1	+0.1	3304	2.4	2.0	−0.4
3322	2.2	2.3	+0.1				
3324	2.2	2.3	+0.1				
3291	2.6	2.6	0.0				
3293	2.2	2.2	0.0				
3320	1.8	1.8	0.0				
3328	1.9	1.9	0.0				
3329	2.1	2.1	0.0				
3318	2.6	2.4	−0.2				
Means	2.20	2.31	+0.11		2.24	2.26	+0.01
Standard deviations	0.25	0.25			0.18	0.19	
Percentage changes	+5%				+1%		
P	*<0.001**				>0.5		
Increase	16 (73%)				4 (29%)		
No change	5 (23%)				7 (50%)		
Decrease	1 (5%)				3 (21%)		
Total	22 (100%)**				14 (100.0%)		

Chi-square = 7.106
P *<0.05**

* Statistically significant
** Approximate

group showed increased scores in contrast to 29 per cent with increase in the control subjects. The importance of this difference is underscored by a chi-square of 7.106 and a $P < 0.05$.

Table III provides the information for glucose versus placebo supplementation. There is a statistically significant ($P < 0.0005$) mean percentage rise of 12 per cent with glucose supplementation, whereas the placebo group showed a zero per cent change which, obviously, is not statistically significant ($P > 0.5$). Furthermore, the table shows that there is a statistically significant quantitative difference ($P < 0.001$).

DISCUSSION

There are a number of features about these studies which deserve re-emphasis. First, it is now reasonably well established that altering carbohydrate intake

TABLE 3

Sulcus depth patterns with glucose versus nonglucose supplementation

Case number	Glucose initial mean scores	Group final mean scores	Difference	Case number	Placebo initial mean scores	Group final mean scores	Difference
13161	2.3	2.7	+0.4	13184	2.7	2.9	+0.2
13164	1.9	2.3	+0.4	13186	2.1	2.2	+0.1
13172	1.9	2.3	+0.4	13204	1.8	1.9	+0.1
13173	2.0	2.4	+0.4	13193	2.0	2.1	+0.1
13181	2.0	2.4	+0.4	13198	1.8	1.9	+0.1
13203	2.0	2.3	+0.3	13167	1.9	2.0	+0.1
13196	2.1	2.4	+0.3	13191	2.0	2.0	0.0
13206	2.1	2.4	+0.3	13158	2.0	2.0	0.0
13183	2.0	2.3	+0.3	13163	2.1	2.1	0.0
13192	2.1	2.3	+0.2	13179	2.1	2.1	0.0
13162	2.0	2.2	+0.2	13178	2.1	2.1	0.0
13205	2.0	2.2	+0.2	13176	1.9	1.9	0.0
13166	1.8	2.0	+0.2	13175	2.1	2.1	0.0
13195	2.1	2.3	+0.2	13194	2.1	2.1	0.0
13168	2.1	2.3	+0.2	13182	1.8	1.8	0.0
13187	1.8	2.0	+0.2	13165	2.1	2.0	−0.1
13177	1.9	2.1	+0.2	13197	2.2	2.1	−0.1
13185	2.1	2.3	+0.2	13169	2.1	2.0	−0.1
13159	2.4	2.5	+0.1	13170	2.0	1.9	−0.1
13171	2.2	2.3	+0.1	13160	2.1	1.9	−0.2
13180	2.5	2.6	+0.1	13199	2.2	1.9	−0.3
Means	2.07	2.31	+0.25		2.06	2.05	−0.01
Standard deviations	0.18	0.17			0.19	0.22	
Percentage changes	+12%				0%		
P	*<0.0005**				>0.5		
Increase	21 (100%)				6 (29%)		
No change	0 (0%)				9 (42%)		
Decrease	0 (0%)				6 (29%)		
Total	21 (100%)				21 (100%)**		

Chi-square = 23.267
P < *0.001**

* Statistically significant
** Approximate

significantly changes sulcus depth very quickly. In these studies, the evidence suggests that alterations may be observed within a three- to four-day period. The validity of the findings in this report is underscored by like observations utilizing other oral parameters of health and disease. Specifically, very similar results were obtained with gingival state and clinical tooth mobility when refined carbohydrates were eliminated from the diet,[3, 4] when sucrose was added,[5, 6] and when glucose was added.[7, 8]

Second, a summary of the findings (Fig. 1) shows quite clearly the consistency of the results. The glucose group (black column) shows a 100 per cent increase in sulcus depth. The sucrose group (described by diagonally hatched column) shows less but a still significant increase in sulcus depth of 73 per cent,

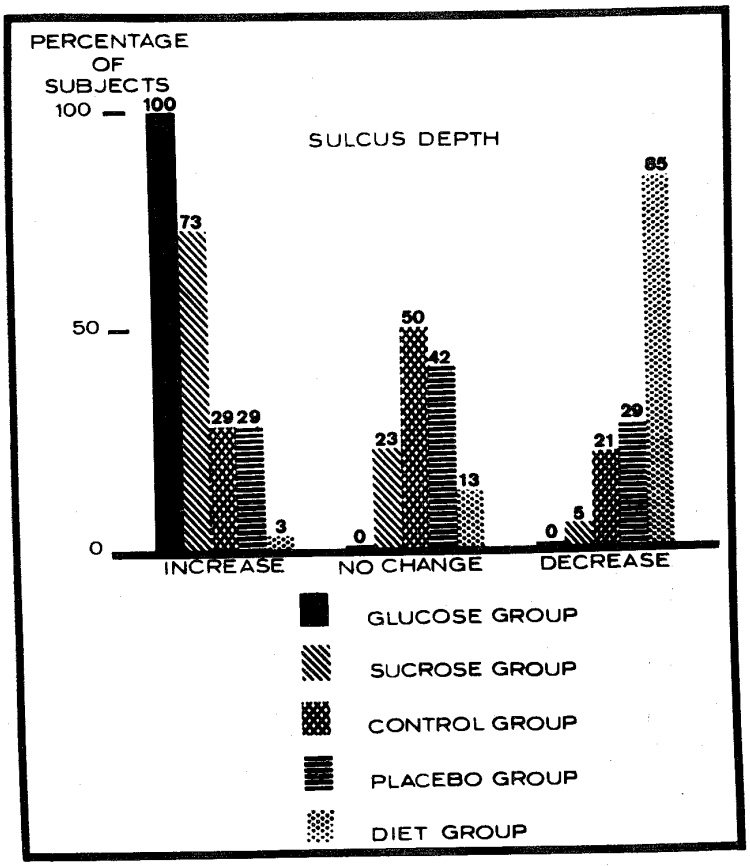

FIG. 1

with only 23 per cent no change and 5 per cent decrease. The control group (characterized by the crosshatching) shows essentially no change as evidenced by an increase in 29 per cent, no change in 50 per cent, and a 21 per cent decrease. The same is true with the placebo (low-calorie) supplement represented by the horizontally hatched columns (29 per cent increase, 42 per cent no change, and 29 per cent decrease). Finally, there is a decided improvement in the group requested to eliminate refined carbohydrates (stippled columns), with 3 per cent increase, 13 per cent no change, and 85 per cent decrease.

Table IV summarizes the mean percentage changes in sulcus depth with the different dietary regimens. A reduction in sulcus depth (13 per cent) is observed only in the diet group (with low refined-carbohydrate and high-protein diet), which is statistically significant ($P < 0.001$). No changes occurred in the placebo and the control groups ($P > 0.5$). Significant increases in sulcus depth are found in the carbohydrate-supplemented groups. It is noteworthy to mention

TABLE 4

Mean percentage changes in sulcus depth with different therapeutic regimens

Groups	Mean percentage change	Significance of the difference of the mean
Diet	−13%	$P < 0.001$*
Placebo	0%	$P > 0.5$
Control	+1%	$P > 0.5$
Sucrose	+5%	$P < 0.001$*
Glucose	+12%	$P < 0.0005$*

* Statistically significant

that the glucose group (the individuals given 225 grams of glucose daily) had a greater increase in sulcus depth (12 per cent) than the sucrose group (given 100 grams of sucrose C.P.), which had an increase of 5 per cent.

Although the evidence presented here suggests that refined carbohydrates may be the proximate cause, this in itself gives no inkling as to the mechanism. Surely, the addition and elimination of refined carbohydrates affects the regulation of carbohydrate homeostasis. Hence, the sulcus depth findings may be due to some hormonal change. Also, there is suggestive evidence that the vitamin and trace mineral state varies directly with carbohydrate metabolism. There is, then, the possibility that the sulcus depth findings may be associated with the various vitamins and particularly the vitamin B complex, as well as certain trace minerals. It is a clinical fact that the intake of carbohydrates and proteins is almost inversely related. In other words, the individual who consumes large amounts of carbohydrate foods frequently does not ingest much protein. Therefore, the possibility exists here that protein metabolism is modified when refined carbohydrate foodstuffs are added and subtracted.

SUMMARY

1. One hundred and eighteen presumably healthy dental students participated in this experiment to demonstrate the effect of the addition and subtraction of refined carbohydrates upon sulcus depth.

2. Reduction in sulcus depth was only found when refined carbohydrates were eliminated from the diet; the greatest increase in sulcus depth was observed when a 225-gram glucose supplement was added. No change in sulcus depth was noted when nothing was done or a placebo given. A deepening in sulcus depth was also observed when 100 grams of sucrose were administered on a daily basis, but the change was not as great as with the 225 grams of glucose, also administered daily.

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