CXV. THE RELATION OF CALCIUM IN THE SALIVA TO DENTAL CARIES.

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PATTISON [1926] concluded that there seems to be some connection between the quantity of calcium in the saliva and dental caries, but to prove this a more prolonged investigation would have to be made. In the following work we have studied this connection on numbers of patients sufficient to exclude the effect of chance variations.

Methods.

Calcium was estimated by the method of Clark [1921] with the modification, suggested by Stanford and Wheatley [1925], of washing the calcium oxalate precipitate with a saturated solution of calcium oxalate instead of distilled water. Before precipitation of calcium as oxalate the mucin in the saliva was removed as far as possible; a drop of 10 % acetic acid was added; the saliva was shaken for half an hour and then filtered through an ash-free paper.

The most likely sources of error in this method are the contamination of the calcium oxalate precipitate with organic matter and the loss of calcium with the precipitated mucin. To check this, estimates were also made on 27 samples by incinerating without removing mucin, dissolving the precipitate in dilute HCl, neutralising to methyl red and continuing the estimation on this solution. On the average the results by the incineration method were 0.1 mg. per 100 cc. higher than those by the direct method; the difference between the two methods was 0.6 mg. on one occasion and 0.3 mg. on another, otherwise the difference did not exceed 0.2 mg.

Duplicates by the direct method agreed well.

The subjects sucked "acid drops" in order to stimulate the flow of saliva.

Variations of salivary calcium in the same individual.

Table I shows that no great differences occur when the secretion of saliva is stimulated by various methods. Table II shows that appreciable variations may occur in the same person throughout the day. As it was impossible to control the conditions under which the subjects were examined, it was necessary to examine a large number in order not to be misled by chance variations.

Table I. *Calcium in saliva (mg. per 100 cc.) after various stimuli.*

	Acid (lemon)	Bitter (quinine sulphate)	Salt (NaCl)	Sweet (dextrose)
	9.15	9.6	9.6	8.3
	9.1	7.7	9.65	9.05
	9.1	8.1	9.5	9.05
	9.2	8.1	9.8	8.8
	8.8	8.4	9.45	9.8
Average	9.06	8.38	9.60	9.00

Table II. *Variations of calcium in saliva (mg. per 100 cc.) during 2 days.*

8 a.m.	10 a.m.	12-1 p.m.	2 p.m.	4 p.m.	6 p.m.	8 p.m.	10 p.m.	12-1 a.m.
7.4	8.0	8.6	7.7	8.0	—	8.4	7.9	5.7
7.9	7.7	8.9	8.4	7.5	—	7.4	7.7	7.7

Relation of salivary calcium to caries.

741 children aged from 3 to 12 years have been examined. They were patients of the dental clinic and children's clinic of the London Hospital, or new inmates of Dr Barnardo's Homes, Barkingside. The results are shown in Table III in which the children are classified according to the number of carious teeth (vertical columns) and the level of calcium in saliva (horizontal rows); early cases are shown in brackets. Thus of the 154 children with two carious teeth, 47 had between 7 and 8 mg. calcium per 100 cc. saliva; while of 141 children with between 8 and 9 mg. calcium per 100 cc. saliva 15 had 4 carious teeth and in 8 of these cases the caries was in the early stages. This table shows very clearly the association between carious teeth and low calcium in saliva. Put in another way, of 86 children with no caries only 7 had under 8 mg. calcium in 100 cc. saliva: while of 159 children with 5 or more carious teeth only 25 had over 8 mg. calcium in 100 cc. saliva, and if we omit the early cases out of 117 only one had over 8 mg.

Table III. *Relation of calcium in saliva to number of carious teeth.*

Calcium in saliva mg./100 cc.	Number of carious teeth									Totals
	0	1	2	3	4	5	6	7	Over 7	
0-1	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	1	1
3-4	0	0	0	0	2	0	2	2	3	9
4-5	0	0	1	2	3	2	4	8	2	22
5-6	0	2	7	11	18	11	11	14	4	78
6-7	1	2	12	32	31	18	12+(1)	11+(1)	2	123
7-8	6	13	47	62	35	5+(10)	3+(3)	0+(3)	1	188
8-9	10	21	44	4+(24)	7+(8)	0+(8)	1+(6)	0+(7)	0+(1)	141
9-10	34	19+(10)	0+(28)	0+(15)	0+(7)	0	0+(1)	0	0	114
10-11	22	0+(9)	0+(8)	0+(1)	0	0	0+(1)	0	0	41
11-12	8	0+(4)	0+(6)	0	0	0	0	0	0	18
12-13	3	0	0+(1)	0	0	0	0	0	0	4
13-14	2	0	0	0	0	0	0	0	0	2
Total	86	80	154	151	111	54	45	46	14	741

The fact that higher salivary calcium is found in the early cases than in those in which the disease is more advanced suggests that the reduction of

calcium is not the primary change. This is supported by the results of treatment. The saliva was examined in 166 cases, about 6 and 10 weeks after the extraction or filling of carious teeth. The results are shown in Table IV; the grouping according to the number of carious teeth is made wider in order to make the number greater. These tables show a definite shift towards higher values of calcium in saliva during the 10 weeks after treatment. Under half of these cases were new inmates of Dr Barnardo's home; in these cases changes might be due to alterations of the conditions of life, but there was no appreciable difference between them and the other cases in which the change could only be due to chance or the result of treatment.

Table IV. *Calcium in saliva after treatment.*

Calcium in saliva mg./100 cc.	One and two carious teeth			Three and four carious teeth			Over four carious teeth		
	Before treat- ment	6 weeks after	10 weeks after	Before treat- ment	6 weeks after	10 weeks after	Before treat- ment	6 weeks after	10 weeks after
4-5	0	0	0	2	0	0	4	0	0
5-6	1	0	0	6	0	1	6	3	0
6-7	4	2	1	17	12	7	9	6	2
7-8	14	17	14	37	28	22	11	11	10
8-9	24	18	19	13	28	31	4	8	11
9-10	29	30	28	9	17	19	0	5	10
10-11	5	7	13	2	2	5	1	2	2
11-12	1	3	3	2	1	3	0	0	0
12-13	0	1	0	0	0	0	0	0	0
Total	78	78	78	88	88	88	35	35	35

It seems therefore that the reduction of calcium in saliva is secondary to the caries. It is difficult to see why this should occur. It might be due to continual slight irritation in the mouth, but in 10 adults with dentures, which one would expect to produce as great irritation as painless caries, the calcium in saliva was normal; in two out of four cases of alveolar abscess, in which the irritation must be much greater, the calcium was high for the number of carious teeth. The changes we found were independent of diet, as far as could be ascertained; there were no obvious differences between boys and girls, or between Gentiles and Jews.

We propose to do further work on conditions which may affect the concentration of calcium in saliva.

We have examined the saliva of 65 children from King Edward VII Hospital, Sheffield, for which specimens we are indebted to Dr Pattison; most of the children were tuberculous and we found calcium concentrations definitely lower than in children of our series with the same number of carious teeth, which agrees with the results of Pattison [1926]; the number investigated, however, is too low for a definite conclusion.

We have estimated the serum- and salivary calcium at the same time in 47 adults, and found no relation between the two.

We estimated the inorganic phosphate in saliva of 54 children. As far as any conclusion can be drawn from this number the inorganic phosphate does not vary with the extent of caries.

SUMMARY.

Dental caries is associated with a reduction of the concentration of calcium in saliva. This reduction appears to be secondary to the caries.

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