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STRONTIUM-90 CONTENT OF SOUND AND CARIOUS HUMAN DECIDUOUS TEETH

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WE PREVIOUSLY found that carious first and second molar crowns contained significantly greater quantities of strontium-90 than comparable sound teeth (ROSENTHAL, *et al.*, 1966). These data were obtained from teeth of St. Louis children born between 1948 and 1953–54 when strontium-90 fall-out was low. No adequate explanation could be formulated to account for this difference although various hypotheses were entertained. It was of interest therefore to determine the strontium-90 content of dentine and enamel of carious and sound deciduous teeth and the nuclide content o carious material in an effort to resolve these differences.

For fractionation of dentine and enamel, 10-g samples of sound and carious tooth crowns from incisors, first molars and second molars were pooled separately for the first and last 6 months of the birth year. Although each category was analysed separately, the data have been averaged for interpretive purposes. In order to obtain sufficient material, teeth of children who were born between 1954 and 1958 and who were bottle fed for 6 weeks or more after birth were used. Root material was removed at the cement–enamel junction and carious lesions were excavated to sound dentine in order to remove all carious matter and debris. The samples were ground in a Wiley Mill to pass an 80 mesh screen, and 2-g portions of whole crown powder were set aside for strontium-90 analysis. The remaining powder was separated into dentine and enamel portions by gravity flotation using S-tetra bromoethane and acetone mixtures (BATTISTONE and BURNETT, 1956). Analysis of strontium-90 was performed on 2-g portions of the fractionated and dried material.

For the estimation of strontium-90 in carious tooth substance, 2 g samples of carious material were carefully removed with a dental bur and all visible pieces of enamel and/or dentine were removed manually. We estimate that the samples contained at least 85 per cent carious material because subvisual particles of non-carious tooth material were undoubtedly present in the samples. Sufficient carious material could be obtained from 250 first molar and 170 second molar crowns that had extensive class 2 lesions. The large numbers of teeth necessary to yield a sample required us to use teeth from breast-fed or bottle-fed children who were born between

1955 and 1958. Although each category for a 6 month or yearly interval of the birth year was analysed separately, the data have been averaged for interpretive purposes.

The samples were ashed at 600°C and analysed for strontium-90 by methods previously described (ROSENTHAL, *et al.*, 1963, 1964). Calcium was determined by permanganate titration of oxalate precipitates or by flame absorption spectrometry using lanthanum chloride as a quenching agent. All data have been corrected for natural decay of strontium-90 ($T/2 \cong 28$ yr) to the birth year of the child. This correction admittedly introduces a small error for the carious material that formed at some time after the birth of the child, tooth eruption or caries formation.

TABLE 1. DISTRIBUTION OF STRONTIUM-90 IN DENTINE AND ENAMEL*

		Sound (A)	Carious (B)	Ratio A/B
		pC/g Ca ± S.E.		
Incisor (6)	Whole tooth	2·80 ± 0·57	2·97 ± 0·50	0·94
	Dentine	3·27 ± 0·52	3·60 ± 0·58	0·91
	Enamel	2·20 ± 0·40	2·44 ± 0·40	0·90†
	E/D	0·67	0·68	
1st Molar (9)	Whole tooth	2·42 ± 0·33	2·99 ± 0·42	0·81
	Dentine	2·67 ± 0·33	3·24 ± 0·34	0·82
	Enamel	1·93 ± 0·19	2·52 ± 0·45	0·77
	E/D	0·72	0·78	
2nd Molar (13)	Whole tooth	2·82 ± 0·32	3·20 ± 0·28	0·88
	Dentine	3·18 ± 0·24	3·75 ± 0·35	0·85†
	Enamel	2·42 ± 0·17	2·85 ± 0·33	0·85
	E/D	0·76	0·76	

*Average values for teeth of children born between 1954 and 1958 who were bottle fed for 6 weeks or more after birth. Comparable samples of sound and carious tooth crowns for first and last 6 month interval of birth year (for number of samples in parentheses) were analysed.

†Indicates $P < 0{\cdot}05$.

Underlined values are significant at $P < 0{\cdot}01$.

As shown in Table 1, the whole crown, enamel and dentine of sound teeth from children born between 1955 and 1958 contain an average of 14 per cent less strontium-90 than comparable fractions of carious teeth. Although this difference is of doubtful significance, the data tend to confirm our previous findings that showed sound whole crowns of first and second molars of children born between 1948 and 1953–54 to contain 34 and 29 per cent less strontium-90, respectively, than carious teeth (ROSENTHAL, *et al.*, 1966). The data also show that enamel consistently contains about 73 per cent of the strontium-90 content of comparable dentine. The lower enamel/dentine ratio appears to be independent of the type of tooth or whether the tooth was sound or carious.

Carious material from first and second molars contains consistently higher quantities of strontium-90 than comparable whole crowns (Table 2—Line A and E). The small amount of carious material/tooth crown results in a contribution of only

TABLE 2. STRONTIUM-90 CONTENT OF CARIOUS MATERIAL*

			1st Molar	2nd Molar
A.	No. of samples analysed		7	11
B.	Whole crown Sr^{90},	pC/g Ca	3·31 ± 0·49	3·88 ± 0·30
C.	Whole crown Ca,	mg/tooth	78 ± 1·2	145 ± 2·6
D.	Whole crown Sr^{90},	pC/tooth	0·26 ± 0·04	0·56 ± 0·04
E.	Carious material Sr^{90},	pC/g Ca	4·55 ± 0·38	4·84 ± 0·45
F.	Carious material Ca,	mg/tooth	1·19 ± 0·17	3·28 ± 0·43
G.	Carious material Sr^{90},	fC/tooth†	5·28 ± 0·46	15·9 ± 1·5
H.	[Caries Sr^{90}/tooth/ /crown Sr^{90}/tooth] × 100		2·17	2·83
I.	Caries Sr^{90}/g Ca/ /crown Sr^{90}/g Ca		1·37	1·25

*Average values ± standard error of the mean for teeth of children born between 1955 and 1958 who were bottle fed or breast fed for 6 weeks or more after birth. Comparable samples of carious material and whole crown for semi-annual or yearly intervals of birth year were analysed.

†Note change of unit to $fC = 10^{-15}C$ as compared with $pC = 10^{-12}C$.

2·2 and 2·8 per cent, respectively, of the strontium-90 found in the entire crown of the tooth (Table 2—Line H). When the data are expressed on the basis of calcium concentration (Table 2—Line I), the contribution is even less. Although the concentration of nuclide is significantly lower than that found in the whole crown, the total contribution is low. This finding suggests that only a small error will be incurred by the use of either carious or sound teeth for comparative or public health purposes.

The lower strontium-90 content of enamel and the slightly higher values for carious material may reflect a situation that occurs during periods of increasing dietary strontium-90. During the period between 1948 and 1958 dietary cow's milk strontium-90 increased from essentially zero to 6·7 pC Sr^{90}/g Ca in the St. Louis area. Thus, enamel would contain less strontium-90 because it is formed earlier in time (in addition to *in utero* calcification), and during lower strontium-90 levels while dentine is formed much later during higher strontium-90 levels. Additions of sclerotic or secondary dentine after tooth formation also contributes additional strontium-90. In like manner, carious material is in contact with higher dietary strontium-90 levels during the period of caries formation than during the time of tooth calcification. Such contact may result in some additional exchange and accretion of the nuclide. If the strontium-90 content of enamel and dentine represents an equilibrium with body fluids and dietary strontium-90, we would expect enamel, dentine and carious material to contain equal amounts of nuclide when available dietary nuclide is constant. Similarly, enamel would contain more strontium-90 than dentine during periods of decreasing strontium-90 availability. These factors cannot be evaluated until teeth of

children born after 1964 and during decreasing strontium-90 milk levels, become available for study.

The present data do not rule out the possibility that intrinsic differences occur in either crystal structure or chemical composition of caries, enamel and dentine as we have previously suggested (ROSENTHAL, *et al.*, 1966).

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