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Effect of Sr^{89} on Fluoride Retention in the Rat.* (25346)

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Increasing numbers of communities using fluoridated water along with the increasing amount of radioactive strontium in the atmosphere have caused considerable speculation whether the mutual presence of fluoride and strontium increases retention of each within the body(1). The purpose of this study is to investigate retention of fluoride and radioactive strontium when both are fed simultaneously in the rat.

Method. One mc of Sr^{89} (as strontium chloride) was diluted to one liter with fluoride-free redistilled water. This stock solution was used throughout the 3 series of experiments. Series I. A total of 24 male Sprague-Dawley rats was divided according to initial body weight into 4 groups of 6 animals each. All animals received a low-fluoride diet (0.05 μg F/g) and fluoride-free redistilled drinking water *ad lib.*, and were housed in an air-conditioned room in individual stainless steel metabolism cages. Animals in Group A served as controls and received no additional supplement. Those in Group B received a single dose of 0.5 ml of Sr^{89} stock solution (501,600 cpm/ml) by stomach tube. Animals in Group C received 0.15 mg F (as NaF) daily by stomach tube, and those in Group D received both a single initial dose of 0.5 ml Sr^{89} and 0.15 mg F daily. Duration of experiment was 10 days. Urine and feces samples were collected separately throughout each 24-hour period. One-half of the urine and feces samples, was analyzed for F by methods previously described (2). The remaining half was analyzed for strontium by charring samples under infrared lamps and ashing for 6 hours in muffle furnace at 600°C. The ash was dissolved in 2 ml 0.1 N HCl, transferred to volumetric flask and diluted with redistilled fluoride-free water to 10 ml. A 1 ml aliquot was placed in an aluminum planchet and evaporated to dryness at 45°C and activity determined with a scintillation counter. Carcasses and femurs were analyzed for F by methods previously described(2). To determine strontium content in calcified tissues, an aliquot of ash was placed in aluminum planchets, dissolved in 2 ml 0.1 N HCl, evaporated to dryness, and the activity counted. Series II was identical to Series I except for amounts of supplemental F and Sr^{89} (Table III) and duration of experiment (20 days). Series III was similar to Series I and II except that its duration was 100 days and supplements were different (Table V).

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TABLE I. Comparison of Fluoride and Strontium Retention in Carcass and Femur of the Rat.
Series I animals

Group	Wt gain (g)	Carcass fluoride μg/g	Carcass fluoride % ret.*	Femur fluoride μg/g	Femur fluoride % ret.*	Sr^{89} analysis (cpm/g ash) Carcass	Sr^{89} analysis (cpm/g ash) Femur
A	21	66 ± 19		69.9 ± 4.3		146 ± 78	121 ± 84
B	23	57 ± 5		60.5 ± 11.6		18,800 ± 800	18,700 ± 1700
C	17	415 ± 28	67	585 ± 33	4.8	196 ± 65	165 ± 56
D	19	398 ± 11	69.7	550 ± 53	5.6	17,800 ± 900	18,600 ± 1900

A = controls; B = .5 ml Sr^{89} (activity of 501,600 cpm/ml); C = .15 mg F; D = .5 ml Sr^{89} plus .15 mg F.

* Based upon total F.

Results of F and strontium retention in Series I animals are found in Table I. When the femurs were used for evaluation of F retention, similar proportional findings to those in the carcass were found except that the amount of fluoride was less.

Excretion data obtained in Series I are found in Table II. Urine contained about 4 times as much fluoride as feces in controls, but about 9 times as much when 0.15 mg F was fed. Similar amounts of radioactivity were found in both feces and urine of control (Group A) and fluoride groups (Group C) due undoubtedly to background activity of the counter. When 0.5 ml of Sr^{89} was administered 1912 cpm were found in feces and 2697 cpm when both F and Sr^{89} were given.

TABLE II. Average Daily Excretion of Fluoride and $Strontium^{89}$ in the Feces and Urine.
Series I animals

Group	Feces μg F	Feces Sr^{89} (cpm)	Urine μg F	Urine Sr^{89} (cpm)
A	1.15	61	4.10	58
B	1.63	1912	3.85	870
C	2.64	60	24.8	60
D	2.23	2697	25.2	729

A = controls; B = .5 ml Sr^{89} (activ. of 501,600 cpm/ml); C = .15 mg F; D = .5 ml Sr^{89} plus .15 mg F.

The F and strontium retention in Series II animals is found in Table III. No differences from controls in F retention were found in the carcass or femur of animals receiving Sr^{89}. When no strontium was administered, but 1 mg F was given daily, activity of carcass was greater than in controls. Significantly less activity was found in the carcass ($p = 0.01$) when both strontium and fluoride were administered than when similar amounts of strontium were given in the absence of F. Similar results were seen for the femur, for significantly less ($p = 0.0001$) activity was found in animals receiving both Sr^{89} and F than in similar animals receiving the same amount of Sr^{89} and no F.

Excretion data for animals in Series II are found in Table IV. In controls 6.6 μg F were found in feces and 18.4 μg in urine. In animals receiving Sr^{89} but no fluoride there was 7.1 μg F in feces and 20.9 μg in urine, similar to values in control animals.

Amount of fluoride and strontium retained in the carcass and femur of the Series III animals is found in Table V.

Discussion. There was a significant difference ($p = 0.001$) in amount of fluoride retained in animals receiving Sr^{89} in both whole carcass and femur when compared to similar animals receiving the same amount of fluoride

TABLE III. Comparison of Fluoride and Strontium Retention in Carcass and Femur of the Rat.
Series II animals

Group	Wt gain (g)	Carcass fluoride μg/g	Carcass fluoride % ret.*	Femur fluoride μg/g	Femur fluoride % ret.*	Sr^{89} analysis (cpm/g ash) Carcass	Sr^{89} analysis (cpm/g ash) Femur
A	60	95.0 ± 18.6		145 ± 17		4,340 ± 960	9,900 ± 2,330
B	52	96.1 ± 8.4		166 ± 15		628,000 ±20,900	821,000 ±54,600
C	43	4410 ± 80	58.5	5860 ±1840	2.6	9,300 ± 1,700	10,780 ± 1,680
D	28	5060 ±200	61.5	5250 ± 990	2.2	562,000 ±28,600	559,000 ±31,200

A = controls; B = .5 ml Sr^{89} (activity of 283,100 cpm/ml); C = 1.0 mg F; D = .5 ml Sr^{89} plus 1.0 mg F.

* Based upon total F.

TABLE IV. Average Daily Excretion of Fluoride and Sr^{89} in Feces and Urine.
Series II animals

Group	Feces		Urine	
	μg F	Sr^{89} (cpm)	μg F	Sr^{89} (cpm)
A	6.6	351	18.4	219
B	7.1	6110	20.9	5570
C	24.6	404	248.0	210
D	41.1	7560	259.0	4610

A = controls; B = .5 ml Sr^{89} (activ. of 283,100 cpm/ml); C = 1.0 mg F; D = .5 ml Sr^{89} plus 1.0 mg F.

but no Sr^{89}. The reason for these reversals in fluoride retention is not known, except that in Series I animals the Sr^{89} was given in one dose at beginning of study, while in Series II and III the Sr^{89} was administered daily. It is reasonable to assume that this daily contact contaminated the animals with fluoride to the degree that there was increased retention of fluoride due to contamination and not due to a metabolic increase in fluoride retention resulting from a physiologic role of Sr^{89} increasing fluoride absorption or retention, or both. This reasoning is substantiated by the results obtained in Group C and D animals in all 3 series, where there were no significant differences in fluoride retention in groups receiving fluoride alone (Group C) or both Sr^{89} and fluoride combined (Group D). It thus appears that presence of Sr^{89} is not associated with increased retention of fluoride in the rat.

The data comparing retention of strontium in presence of fluoride is of interest, since the data suggest that fluoride protects against strontium retention. In Series I animals, presence of fluoride given once at beginning of study resulted in no more Sr^{89} retained in either the whole carcass or the femur than was found in absence of fluoride. In the study lasting 20 days (Series II) where both Sr^{89} and fluoride were given daily there was significantly less ($p = 0.01$) activity in whole carcass and in femur in the group receiving both Sr^{89} and fluoride than in the group receiving Sr^{89} and no fluoride. In the 100 day study (Series III) retention of Sr^{89} in presence of fluoride was not significantly different from that in animals receiving Sr^{89} and no fluoride. More data are needed, however, before definite conclusions should be drawn as to protective effect of fluoride against strontium retention. In any event, the data demonstrate that fluoride does not *increase* retention of strontium in the body of the rat. Differences between carcass Sr^{89} retention and skeletal Sr^{89} retention in presence and absence of fluoride need further investigation also, especially in the light of recent evidence suggesting that certain nutrients may increase retention of fluoride in both soft tissue and skeleton(3,4).

Excretion data (Tables II and IV) also suggest that daily administration of fluoride tends to protect against Sr^{89} accumulation in the skeleton. For example in animals receiving Sr^{89} and fluoride for 10 days (Table II) there was an activity of 2,697 cpm in the feces (Group D), and 729 cpm in urine, whereas the group receiving identical amounts of Sr^{89} but no fluoride (Group B) had significantly less ($p = 0.03$) activity in feces and significantly more in the urine ($p = 0.05$). This suggests that presence of fluoride renders Sr^{89} less metabolically available. This is similarly confirmed by examining amount of Sr^{89} activity in the carcass and femurs in these various groups. For example, there was an activity of 17,800 cpm in whole carcass of Series I animals receiving both Sr^{89} and fluoride (Group D) but 18,800 cpm were found in animals receiving an identical amount of Sr^{89} but no fluoride (Table I). Similar conclusions can

TABLE V. Comparison of Fluoride and Strontium Retention in Carcass and Femur of the Rat.
Series III animals

Group	Wt gain (g)	Carcass fluoride μg/g	Carcass fluoride % ret.*	Femur fluoride μg/g	Femur fluoride % ret.*	Sr^{89} analysis (cpm/g ash) Carcass	Sr^{89} analysis (cpm/g ash) Femur
A	158	18.8 ± 1		21.2 ± 1		.8 ± .35	
B	154	45.5 ± 4		56.9 ± 2		14,100 ± 399	17,800 ± 900
C	156	2370 ± 130	44.7	2810 ± 70	1.81	69.5 ± 6.3	647 ± 47
D	171	2240 ± 180	43.8	2810 ± 127	1.92	15,400 ± 846	19,400 ± 998

A = controls; B = .5 ml Sr^{89} (activity of 50,470 cpm/ml); C = .5 mg F; D = .5 ml Sr^{89} plus .5 mg F.
* Based upon total F.

be drawn from Series II metabolism (Table IV) and retention (Table III) values.

While these conclusions seem to be an accurate evaluation of the data obtained, the long term effects of mutual feeding of both Sr^{89} and fluoride under a variety of different conditions should be evaluated before making definite conclusions. It does appear, however, that presence of fluoride, at 3 different levels, is not associated with increased retention of Sr^{89} in the body, nor, conversely, is the presence of Sr^{89} associated with increased retention of fluoride in the body.

Conclusions. Administration of Sr^{89} and fluoride together does not increase retention of either Sr^{89} activity or fluoride in the whole carcass or femur of the rat. Preliminary evidence suggests, on the contrary, that presence of fluoride may decrease the amount of Sr^{89} retained by the rat.

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ECHO 11 Virus Associated with Aseptic Meningitis.* (25347)

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Several enteroviruses have clearly been associated with aseptic meningitis(1-3). Most prominent among this group are ECHO virus types 4, 6, 9, and 16; Coxsackie types A7 and A9, B1-5; and poliovirus types 1-3. Other types have been isolated from sporadic cases. Until the time of this study, ECHO 11 had been isolated only from normal children(4,5) and from sporadic cases of diarrhea(6). The present report is concerned with an outbreak of aseptic meningitis connected with this virus.

History of outbreak. During latter part of June and July, 1958, at least 7 children were admitted to Jefferson Davis Hospital with a febrile illness characterized by pleocytosis of the cerebrospinal fluid. In addition a mother of one of these children was admitted to the hospital as a "suspected case of poliomyelitis." The most common symptoms at time of admission were: frontal headache, vomiting, spiking fevers to 103°F, stiff neck and joints, acute abdominal pains, and occasional diarrhea and swollen cervical glands. Further physical examination did not show skin rash or mouth lesions. Duration of acute illness was 3 to 7 days. Hematological examination usually yielded a few immature blood cell forms. White blood cells, generally lymphocytes, in the cerebrospinal fluid ranged from 35 to 440/mm^3. The diagnosis was aseptic meningitis, etiological agent unknown. Five of the 7 children lived in a low rental housing project of 1000 dwelling units for low income families. The majority of units are rows of 2-story apartments. The buildings are constructed of concrete with adequate bathroom and cooking facilities in each family unit. Occasional inspection by the administration keeps the living quarters in good repair. Insect control is part of this service. There are ample playground facilities for children. Visiting among neighbors in adjacent homes is very common, especially among children. It is not unusual for the Public Health Nurse to visit each family periodically to check on communicable diseases. A vaccination program is carried out through the hospital clinic and most children visited had received vaccines against diphtheria, whooping-cough, poliomyelitis, typhoid, and tetanus. *Field study.* Because of ease of collection and handling, it was decided to obtain only rectal swabs. Specimens were collected in 3 ml of M-H medium(7) containing a 10-fold concentration of

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