

CALCIUM AND STRONTIUM TRANSFER THROUGH
THE INTESTINAL WALL IN 6- AND 26-WEEK OLD
RATS

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The total transport of calcium and strontium through and the retention in the wall of various small intestinal segments was studied in female albino rats 6- and 26-weeks old. The *in vitro* method of the »everted intestinal sac« was used. Only in the duodenum was the transport of calcium and, to a lesser extent strontium, affected by the age, being significantly more intensive in the young animals.

The metabolism of a number of minerals differs between young and old organism (1—5). A young organism is, also, frequently less able to discriminate some of the ions in the intestinal tract so they become more absorbed (6—8).

The purpose of this study was to examine to what extent the age of rats determines the transport of calcium and strontium through different segments of the intestine. As is well known these ions behave in the organism more or less alike and radioactive strontium may compete with calcium for deposition in the organism.

METHODS

Six and twenty-six-week-old female albino rats of 100 to 110 and 220-230 g body weight resp. were kept on a standard laboratory diet with drinking water *ad lib*. Eighteen hours before the experiment the feeding was discontinued. After the animals were sacrificed by decapitation the duodenum, jejunum and ileum of each rat was processed by Wilson and Wiseman's method for the everted sac (9).

Ten μCi of carrier free ^{45}Ca or ^{85}Sr (Radiochemical Centre, Amersham, England) was added to 100 ml of modified Krebs-Ringer solution (pH 7.4). To this solution either calcium or strontium chloride ($0.5 \times 10^{-4}\text{M}$) was added. Radioactive was only the outside solution. The method was similar to that described before (10). After incubation the activity of each marker was determined in the serosal and mucosal solutions (^{45}Ca by a Geiger-Müller counter and ^{85}Sr by a liquid scintillation counter connected to a one-channel Nuclear Chicago analyzer).

Empty intestinal segments were ashed at 600°C for 18 hours and dissolved in warm hydrochloric acid. ^{45}Ca and ^{85}Sr in these samples were assayed in the same way as in the mucosal and serosal solutions.

RESULTS

The mean ratios of the serosal to the mucosal content of ^{45}Ca and ^{85}Sr are given in Table 1. The groups contained 14 to 30 samples.

Table 1
Total transfer of ^{45}Ca and ^{85}Sr through the wall of different segments of the small intestine in 6- and 26-week old female rats

Age (weeks)	Segment	Calcium-45	Strontium-85
6	duodenum	1.98 ± 0.18 (14)	0.34 ± 0.02 (17)
	jejunum	0.38 ± 0.02 (27)	0.33 ± 0.02 (17)
	ileum	0.35 ± 0.02 (25)	0.30 ± 0.03 (17)
26	duodenum	0.38 ± 0.03 (27)	0.21 ± 0.01 (16)
	jejunum	0.33 ± 0.02 (26)	0.40 ± 0.04 (16)
	ileum	0.35 ± 0.02 (26)	0.37 ± 0.03 (17)

The results are mean ratio of ^{45}Ca and ^{85}Sr in the serosal to that in the mucosal fluid with the standard error of each mean.

The number of samples in each experiment is indicated in brackets.

The calcium and strontium transport was diminished in the older rats, but only for the duodenum. Although this finding is beyond any doubt ($P < 0.001$), the effect of age is much more pronounced in the case of calcium transport. For instance, 62% of strontium, but only 19% of calcium passes through the duodenal wall segment of old animals compared to the young ones. On the contrary, strontium transport through the distal parts of intestine in the older animals is significantly greater ($P < 0.001$) than it is through the duodenum of the same animals. A significant difference between calcium and strontium ($P < 0.001$) was observed only with the duodenal segment of both groups of animals, but with a much larger difference for the younger ones.

Table 2
Retention of ^{45}Ca and ^{85}Sr in the wall of different intestinal segments in
6- and 26-week old rats

Age (weeks)	Segment	Calcium-45		Strontium-85	
6	duodenum	35.70 ± 1.91	(12)	23.75 ± 0.88	(17)
	jejunum	18.45 ± 1.32	(27)	17.80 ± 0.46	(17)
	ileum	20.65 ± 1.24	(27)	17.10 ± 0.83	(17)
26	duodenum	21.94 ± 1.49	(26)	18.64 ± 0.58	(17)
	jejunum	20.20 ± 1.49	(26)	17.78 ± 0.87	(16)
	ileum	21.28 ± 1.57	(27)	15.87 ± 0.36	(14)

The results are expressed as percent of the initial mucosal solution ± SE.
The number of samples in each experiment is indicated in brackets.

The content of ^{45}Ca and ^{85}Sr in the intestinal wall is shown in Table 2, expressed as percent of the initial mucosal solution. The retention of calcium and strontium is significantly largest ($P < 0.001$) in the duodenal wall of the younger animals, with the greatest difference between the two ions in the same segment.

DISCUSSION

The results presented here confirm those of other authors as well as our earlier ones in that the absorption of calcium (11, 12), and its transport in the duodenum diminishes with the age of the animals (3). Similar effect could be observed in the same intestinal segment for the transport of strontium, but it is much smaller. This distinction between the two ions is most probably due to the fact that in the duodenum of the younger organism calcium moves from the mucosal to the serosal side mostly by active transport (13, 14). In the sixth month of life this active calcium transport diminishes to less than one half of its initial value (2, 3). Although the active transport of strontium is said to exist in the duodenum of younger animals (13) it is never so intense.

It is interesting that the strontium transport in older animals is significantly larger in the more distal parts of the intestine than it is in their duodenum. It is difficult to explain, but it may be possible that in older animals the mucosal membrane is more susceptible to the passive transport in the distal parts of the intestine than it is in their duodenum. Of course, if such an interpretation is valid one would expect the same effect for other ions too. Calcium certainly does not behave in this way.

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Sažetak

TRANSPORT KALCIJA I STRONCIJA KROZ CRIJEVNU STIJENKU
STAKORA STARIH 6 I 26 TJEDANA

Ispitivali smo ukupni transport kalcija i stroncija kroz stijenku različitih segmenata tankog crijeva u 6 i 26 tjedana starih ženki bijelog štakora. Koristili smo *in vitro* metodu »izvrnute crijevne vreće«.

Transport kalcija, a u manjoj mjeri i stroncija, bio je značajno intenzivniji jedino u duodenumu mlađih životinja.

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