

EFFECT OF CALCIUM AND PHOSPHATES ON THE RATIO OF NONABSORBED STRONTIUM TO CALCIUM IN THE GUT

S. VOJVODIĆ and KRISTA KOSTIAL

*Institute for Medical Research, Yugoslav Academy of Sciences and Arts, Zagreb
(Received for publication December 29, 1967)*

The results of direct measurements of nonabsorbed radioactive strontium and calcium in the gastrointestinal tract 300 mins. after the radioactive isotope application show an increased $OR_{\text{digestive tract/standard}}$ value for animals given 0.5 m mols of CaCl_2 and a decreased value for animals receiving 0.5 m mols of KH_2PO_4 . This confirms earlier findings of a selective action of phosphates on strontium absorption from the gut.

The results obtained so far in the study of the effects of dietary calcium on the absorption of ingested radioactive strontium show that calcium significantly affects strontium metabolism (1, 2, 3). Higher dietary levels of calcium cause a reduction in strontium absorption, but also produce a considerably stronger effect upon the absorption of radioactive calcium, thus reducing discrimination against strontium (4). On the other hand, phosphates seem to produce a selective action on the gastrointestinal radiostrontium absorption exerting no significant effect upon the absorption of calcium (5, 6). All these data, however, were obtained indirectly by measuring the amount of radioactive strontium and calcium retained in the skeleton after oral application of the radioisotopes.

METHODS

In this experiment we tried to measure directly the changes in the ratio of nonabsorbed strontium to calcium in the gut. Female albino rats aged 14 weeks were used in experiments. Before the beginning of the experiment they were fed standard rat diet and drank tap water ad libitum. At the end of a 12-hour starvation period all animals received a dose of 0.2 μCi ^{85}Sr and 0.2 μCi of ^{47}Ca in a volume of 1 ml by stomach tube. They were divided into 3 groups: the first was given 0.5 m mols of calcium as calcium chloride together with the radioactive

isotopes; the second group received radioisotopes with an equimolar amount of potassium dihydrogen phosphate (0.5 m mols) while the third served as a control and received isotopes in distilled water. In the intervals of 5 and 300 mins. following the isotope application animals were sacrificed by decapitation. After total exsanguination the abdominal cavity was opened and the oesophagus and rectum were tied by a ligature. The entire gut with its contents was removed by blunt dissection and repeatedly rinsed in distilled water to remove all possible traces of blood on the external walls of the gut.

The entire gut was then placed into a suitable glass vessel and radioactivity was determined in a well-type scintillation counter with a 3"×3" crystal in conjunction with a single channel analyser. To secure the necessary geometry of counting the gut was always placed into the measuring vessel in the same way – the oesophagus at the bottom, the rectum on top. The radioactive dose applied to rats (1 ml volume) diluted with distilled water to a volume of 11 ml (what approximately corresponded to the volume of the digestive tract) was used as a standard. The results are expressed as the ratio of $^{85}\text{Sr}/^{47}\text{Ca}$ in the standard solution ($\text{OR}_{\text{digestive tract/standard}}$) (7).

RESULTS AND DISCUSSION

In earlier preliminary experiments we found that the values for endogenous secretion of radioactive calcium and strontium as well as the radionuclides in the intestinal wall can be neglected for time intervals used in this experiment. Therefore, only the total radioactivity of the entire isolated digestive tract was recorded.

Table 1

Effect of calcium and phosphates on the ratio of nonabsorbed ^{85}Sr to ^{47}Ca in the gastrointestinal tract ($\text{OR}_{\text{digestive tract/standard}}$)

Time (min.)	No. of rats	CaCl_2 0.5 m mols	KH_2PO_4 0.5 m mols	Control
5	14	0.961 ± 0.009	0.974 ± 0.041	1.061 ± 0.012
300	15	1.224 ± 0.021	2.032 ± 0.088	1.628 ± 0.067

Radioactive isotopes of strontium and calcium and CaCl_2 and KH_2PO_4 were applied in a single dose by stomach tube.

The results presented in Table 1 show that the value of $\text{OR}_{\text{digestive tract/standard}}$ in all animals sacrificed 5 mins. after the radioisotope application are almost the same – about 1. However, in the interval of

300 mins. after the application of radioactive isotopes significant differences in the values of $OR_{\text{digestive tract/standard}}$ were observed. While in the control animals these values were 1.63 what agrees with the well-known fact about higher absorption of calcium from the digestive tract (8), under the influence of calcium chloride this value was significantly reduced from 1.63 to 1.22 ($P < 0.001$). This proves that the stable calcium produces a stronger effect on calcium than on strontium absorption (4). However, in the group of animals exposed to phosphates the value of $OR_{\text{digestive tract/standard}}$ rose from 1.63 to 2.03 ($P < 0.001$). It is accordingly concluded that phosphates actually selectively affect strontium absorption. It is assumed that this is due to the formation of strontium phosphates which are less soluble than those of calcium.

ACKNOWLEDGEMENT

We wish to express our thanks to Prof. C. L. Comar, Cornell University, Ithaca, N. Y., for usefull advice and suggestions during this work.

References

1. MacDonald, N. S., Spain, P. C., Ezmirlan, F., Rounds, D. E.: *J. Nutrition*, 57 (1955) 555.
2. Wasserman, R. H., Comar, C. L., Papadopoulou, D.: *Science*, 126 (1957) 1180.
3. Comar, C. L., Wasserman, R. H., in: *Mineral Metabolism*, II-A, C. L. Comar, F. Bronner, Academic Press, New York, 1964, p. 523.
4. Thompson, R. C., Palmer, F. R.: *Am. J. Physiol.*, 199 (1960) 94.
5. Kostial, K., Uojvodić, S., Gruden, N., Lutkić, A., in: *Bone and Tooth*, Pergamon Press, Oxford, 1963, p. 111.
6. Kostial, K., Lutkić, A., Gruden, N., Uojvodić, S., Harrison, G. E.: *Intern. J. Radiation Biol.*, 6 (1963) 431.
7. Comar, C. L., Wasserman, R. H., Nold, M. M.: *Proc. Soc. Exp. Biol. Med.*, 88 (1956) 232.
8. Wasserman, R. H., in: *The Transfer of Calcium and Strontium Across Biological Membranes*, Academic Press, New York, 1963, p. 211.

Sadržaj

DJELOVANJE KALCIJA I FOSFATA NA OMJER NEAPSORBIRANOG STRONCIJA PREMA KALCIJU U PROBAVNOM TRAKTU

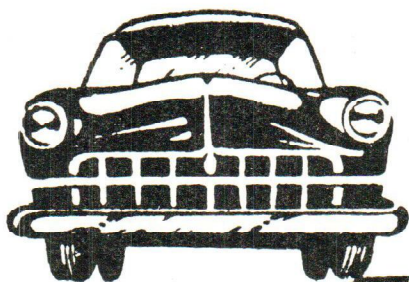
Direktnim mjerenjem omjera neapsorbiranog stroncija-85 prema kalciju-47 u probavnom traktu 300 minuta nakon primjene radioaktivnih izotopa ustanovili smo da fosfati (0.5 m mola KH_2PO_4) izazivaju povišenje vrijednosti $OR_{\text{probavni trakt/standard}}$ a kalcij (0.5 m mola $CaCl_2$) izaziva sniženje te vrijednosti. Ti rezultati potvrđuju ranije indirektno nalaze o selektivnom djelovanju fosfata na apsorpciju radioaktivnog stroncija iz probavnog trakta.

*Institut za medicinska istraživanja
i medicinu rada, JAZU, Zagreb*

Primljeno 29. XII 1967.

SNAGU
kamionu

BRZINU
putničkim kolima



BOSANSKI BROD

Rafinerija nafte
tel. 14, 15 i 16

daje
naše **dizel-gorivo**

i premium zeleni 86

