The Effect of Achylia Gastrica in Rats on the Absorption of Dietary Iron (34436)

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The purpose of this investigation was to study the long-term effects of achylia gastrica in rats on the absorption of dietary iron. There are still conflicting opinions about the necessity of gastric secretion or acid for optimal assimilation of dietary iron in man and experimental animals (1, 2). We proposed to study therefore measures of iron assimilation in rats with achylia gastrica fed normal diets and to compare them with appropriate controls.

Materials and Methods. Female Sprague-Dawley rats were obtained as weanlings and at 23 days of life divided into three groups: Group 1, 10 rats; group 2, 14 rats; and group 3, 9 rats. Achylia gastrica was produced in group 1 by a method we have already described (3). Briefly, it consisted in mobilizing the stomach through a mid-line incision in the abdomen, then exposing it to 1750 rads of X-irradiation while the rest of the rat was shielded. After this procedure enduring gastric atrophy appeared with the pH of gastric juice rarely less than 7.0. This group was then fed Purina Laboratory Chow which contained 275 μg + 29[1] of iron. Group 2, normal untreated rats as controls were placed on a diet of low iron content consisting of Carnation evaporated milk supplemented with 18 ppm of copper as copper sulfate which we had used successfully before (4). Group 3 were normal rats as controls which received the Purina Laboratory Chow diet. The study began at 23 days of age and ran until the rats were 168 days old. The weights and the hemoglobin levels were determined at frequent intervals. On day 145 of the study, a 4-hr collection of gastric juice was made on each rat by the Shay technique (4) and the pH of the juice determined. The animals were then killed and the livers removed and weighed. The nonheme iron was extracted from aliquots of liver by the technique of Bruckman and Zondek (6) and the iron then measured by atomic absorption spectroscopy.

Because we found the liver iron stores of group I (achylia gastrica) to be low, we decided to check for blood loss as a possible cause. This could have resulted from hyperemia of the gastric mucous membrane after irradiation of the stomach. Five control rats and five rats with stomachs just irradiated were injected intravenously with 0.25 μCi of ^{59}Fe as ferrous citrate in 0.2 ml saline. Total body radioactivity was then determined weekly for 6 weeks in a Packard Armac scintillation counter No. 442.

Results. The mean weight gain of groups 1, (+302 g) and 2, (+332 g) were very similar but they were significantly less than group 3, *i.e.*, normal on laboratory chow (+420 g). In the first 72 days of the study the mean weight gain of the irradiated group (group 1) was slower than the group on milk (group 2).

The mean hemoglobin levels fell in groups 1 and 2 reaching a nadir of 7.1 g/100 ml in group 1 33 days after irradiation, and of 8.8 g/100 ml in the milk-fed rats 22 days after beginning the diet. Thereafter the hemoglobin levels rose slowly so that at the end of the study they were in grams per 100 milliliters ± SEM: Group 1, 13.0 ± 0.79, group 2, 13.8 ± 0.64, and group 3, 15.3 ± 0.73.

Table I records all final data with standard errors of the mean and their significance from the controls where applicable determined by the Student *t* method.

The pH of gastric juice from irradiated rats (7.3 ± 0.42) was much higher than that

[1] SEM.

TABLE I. Mean Data from Dietary Study.

	Group and diet	Weight gain (g)	Hemoglobin gain (g/100 ml)	Gastric juice (pH)	Liver nonheme iron (μg/g)
1	Gastric atrophy on chow (10)	+302	+1.5	7.3 ± 0.42	95 ± 33[a] $p < .001$[b]
2	Normal on low Fe (14)	+322	+2.3	1.61 ± 0.19	126 ± 35 $p < .001$
3	Normal on chow (9)	+420	+3.8	1.28 ± 0.13	263 ± 41

[a] ± One standard error of the mean.
[b] p values (Student t) related to group 3.

from nonirradiated rats; 1.61 ± 0.19 for group 2, and 1.28 ± 0.13 for group 3. The mean concentration (μg/g ± SEM) and mean total amounts of nonheme iron (μg) in the livers of irradiated group 1 (95.5 ± 33 and 919) and the milkfed group 2 (126 ± 35 and 1232) were significantly less than that for the normal group 3 (263 ± 41 and 3235).

After the intravenous injection of ^{59}Fe into irradiated control groups, no significant difference in fall of activity was observed between the two groups over a 6-week period. (Fig. 1).

Discussion. At the end of this study rats with achylia gastrica fed normal diets had iron stores similar to rats fed iron-poor diets, but much lower than normal rats fed normal diets. It seemed unlikely that the low iron stores in rats with achylia were due to blood loss from the stomach in view of the results of the parenteral ^{59}Fe study. This left defective assimilation of dietary iron in growing rats as the likely cause of the lower Fe stores, hemoglobin levels, and body weights in rats with achylia. It was possible that irradiation itself, *i.e.*, given at any site, could have reduced appetitie or inhibited iron absorption through a depressing effect on erythropoiesis. However, it should be observed that despite the low iron stores, the hemoglobin levels were not unduly low implying that hemoglobin synthesis was not affected other than through the poor supply of iron. Furthermore, the experiment continued well beyond the range of the inflammatory effects of radiation so that the animals had had normal eating habits for a long period. We have since studied the effect of irradiation of rat limbs with 1750 rads on gastric acid, pH, and iron absorption as part of another project to be reported later. The effects were negligible.

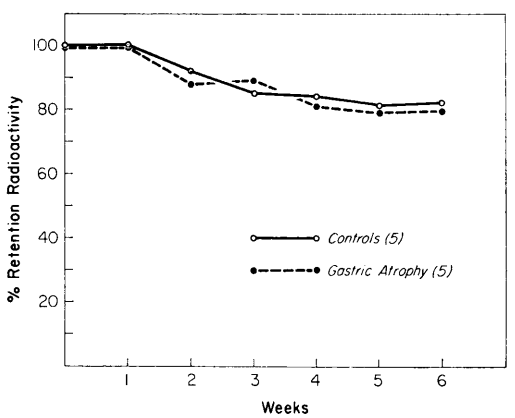

FIG. 1. Percentage of retention of parenteral 0.25 μCi ^{59}Fe by rats.

Summary. Achylia gastrica induced in growing rats by X-irradiation of the exposed stomach led to iron depletion despite a normal diet. This implied that gastric secretion or acid was essential for the optimal assimilation of dietary iron by rats.

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