ABSORPTION OF RADIOACTIVE IRON AND ITS ASSIMILATION BY ERYTHROCYTES IN ANEMIA CAUSED BY PARTIAL DENERVATION OF THE STOMACH

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Experiments involving the use of radioactive iron have shown that considerable absorption of iron takes place from the digestive tract of dogs suffering from various forms of anemia, and that this process is virtually absent in control animals [11, 12]. The radioactivity of the blood plasma reaches a maximum 1-2 hours after administration of iron, and is totally absent a few hours later. It has been established that the intensity of iron metabolism is determined in the first place by the functional requirements of the organism [1, 6, 9, 10].

We have applied radioactive isotopes to the study of various forms of experimental anemia caused by denervation of certain viscera, and described by V. N. Chemigovskii and his associates [8].

The present paper gives data relating to the absorption of the radioactive iron isotopes Fe59 (as Fe59Cl3) from the alimentary tract, and to its utilization for the synthesis of hemoglobin in dogs rendered anemic by partial denervation of the stomach. As a control of the absorptive power of the alimentary tract we also applied the previously obtained data [2] for absorption of radioactive phosphorus (given as Na32P5O10).

EXPERIMENTAL METHODS

We examined the absorption of iron and the rate of its incorporation into hemoglobin:

1. In healthy dogs, before operation (dogs Beliak and Malysh).

2. In dogs during the stage of hypochromic anemia supervening after operation for a Pavlov pouch (control, Malysh) or a Klemensiewicz-Heldenhain pouch (partial denervation; the dog Veselyi). The dog Veselyi was further studied during the stage of development of hyperchromic macrocytic anemia.

3. In dogs in which both vagus nerves have been divided below the diaphragm during the stage of hyperchromic macrocytic anemia, and after normalization of the blood picture (Bars, Tarzan, Fokus), and in a control dog in which the esophagus had been exposed below the diaphragm, without injury to the nerves (Beliak). In addition, we examined absorption of P32 in the dogs Bars and Tarzan. As controls for these experiments we used the healthy dogs Zhuchka and Rozka.

The radioactive isotopes were administered orally, in 250 ml of milk, at the dosage levels: iron - 1000 cpm phosphorus - 500 cpm per 1 g body weight.

Blood samples were taken 15, 30, 60, 90, 120, 180, 240, and 300 minutes after administration of isotopes, on the first day of administration, and thereafter once daily for the 3-5 days following, and then once in 4-8 days. Each animal was observed over a period of 4-8 months. Radioactivity was measured by means of a Type B counter. The mean error of the measurements did not exceed 3-4%.

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We calculated the percentage of the given dose per 1 g body weight found in 1 ml of plasma, and the rate of incorporation of Fe\(^{59}\) into hemoglobin from the percentage of the given dose per 1 g body weight found in the erythrocytes of 1 ml of blood (taking into account the hematocrit readings). Serum radioactivity after administration of \(^{59}\)Fe was measured by means of a B-2 counter, and total phosphorus was determined colorimetrically. The specific activity of total serum phosphorus was then calculated. Blood morphology and biochemistry were studied parallel with these measurements [2].

**EXPERIMENTAL RESULTS**

1. In healthy dogs radioactive iron was found in the plasma 15-30 minutes after its introduction, and reached peak concentration within 120-240 minutes, diminishing gradually thereafter. The radioactivity of the plasma was negligible after 48-72 hours (Fig. 1, 1, 3).

Radioactivity appeared in the erythrocytes on the 4-5th day after administration of iron, and was maximum on the 8-9th day, remaining at this level for a long time, and then falling gradually. After 4 months the Fe\(^{59}\) content of the erythrocytes did not exceed 1% (see Fig. 1, 1a, 3a).

2. Post-operation hypochromic anemia developed in the dog Malys after a Pavlov pouch operation (erythrocytes 3,500,000, hemoglobin 47%); the condition lasted for 1.5 months. An analogous form of anemia supervened in the dog Vesely after operation for a Klemsiewicz-Heidenhain pouch (erythrocytes 2,880,000; hemoglobin 28%). The erythrocyte count and the hemoglobin content rose slightly after 1.5 months, but, in contrast to Malys, reestablishment of the initial levels was not achieved. The erythrocyte count was 1-1.2 million below normal, and the hemoglobin content remained low by 14-18%. After 3.5 months the anemia was of the hyperchromic macrocytic type, and persisted throughout the period of observation (8 months).

Radioactive iron was administered to both dogs during the postoperative phase of hypochromic anemia. Radioactivity measurements revealed pronounced intensification of absorption. On the first day of administration the plasma Fe\(^{59}\) level exceeded the preoperative one by 4-4.5 times, and remained at a high level up to 5-6 days (see Fig. 1, 4, 5). The radioactivity of the erythrocytes was also 7-12 times higher than before the operation, reaching a maximum on the 6-7th day. It remained at this level for a very long time (over 80 days; see Fig. 1, 4a, 5a).

A second dose of radioactive iron was administered to the dog Vesely during the phase of hyperchromic macrocytic anemia. As is evident from curve 6 (Fig. 1), absorption of iron was much lower, although still higher than in normal dogs. A similar effect was observed with respect to radioactivity of erythrocytes (see Fig. 1, 6a), it follows that incorporation of iron into hemoglobin proceeded more intensively than in healthy dogs, but less so than during the postoperative phase of hypochromic anemia.

3. After subdiaphragmatic division of the vagus nerves of the dogs Bar, Tarz, and Fokus hyperchromic macrocytic anemia developed, lasting for 3-4 months. The erythrocyte count fell by 1.5-2 million, and the hemoglobin content by 15-22%.

Radioactive iron was administered to these dogs, at the height of the anemic phase. The radioactivity of the plasma was found to be 3-4 times lower than in normal dogs; neither on the following day nor thereafter did we find even traces of activity (Fig. 2, B, 1-3). The erythrocytes displayed activity on the 3rd and 5th days after administration of iron, and, as with the preceding dogs, the activity rose to a maximum on the 6-7th day, although, its level was considerably lower (see Fig. 2, B, 1a, 2a, 3a). It may be concluded that, despite the development of anemia, division of the vagus nerves is associated with a sharp fall in absorption of iron and in its assimilation by erythrocytes. A similarly pronounced retardation of absorption of \(^{59}\)Fe from the alimentary tract was observed for these same dogs. This is clearly shown by comparison with the data for control dogs (see Fig. 2, A, 1, 2, and 3, 4). After a second dose of radioactive iron we again found inconsiderable absorption from the alimentary tract (see Fig. 2, B, 4, 5).

Measurements of the radioactivity of feces collected during 3 days (a representative sample was taken, and an aliquot of its suspension in water was taken for radioactivity measurement) showed that 88% of the administered iron was excreted.

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* The actual figure is probably still higher, as the radioactivity of the contents of the intestines is not included in it.