Symposium III. Ferrokinetics

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Studies on Iron Metabolism with a Whole Body Counter

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Iron Absorption; Whole body counting was performed after oral dose of 2 μCi of ^{59}Fe in 4 mg carrier in the form of $FeSO_4$. Increase of iron absorption was observed in iron deficiency anemia, hemochromatosis and probable latent hemocromatotic subjects in the family of hemochromatosis.

Iron Loss; Main route of iron loss was the loss into the gastrointestinal lumen. All of the iron deficient patients ever examined had increased absorption and marked gastrointestinal bleeding. In hemosiderosis, loss of radioiron by epithelial exfoliation was high and characteristic. Total body iron loss and the loss in stool and urine showed no significant difference, and the loss of iron by the loss of hair and desquamation was negligible. In the optimal geometry, the whole body radioiron loss curve was symmetrical as compared to the cumulative activity curve of excreta. The cumulative radioiron loss curves in stool consisted of two components representing exfoliation and bleeding, and the epithelial iron turnover rate (EITR) was calculated from % Epithelial Uptake and PITR.

The highest EITR was found in hemochromatosis (2.6 mg/day or 0.53 mg/kg/day), while a normal had EITR of 0.09 mg/day or 0.0007 mg/kg/day. Whole body retention curve in normal in one meter arc geometry showed the change of counts after 120 days as the repetition of the change in the first 24 hours after the intravenous radioiron injection. Thus the effect of geometry to the internal movement of radioiron was available for the determination of red cell life span.

Iron Distribution; A clinical whole body counter developed by the speaker enabled the quantitative measurement of radioiron distribution in the body sections along the body axis. Factors for the correction of gamma-ray absorption in each body section was obtained by fundamental studies and applied in each case. Photopeak area of ^{59}Fe gamma-rays was used for body section counting with 2 cm slit and 6 collimators were removed for the body retention study.

Erythroid marrow was visualised by subtracting tissue radioiron background of 10 days from the curve at 6 or 24 hours. The tissue radioiron distribution was obtained by subtracting RBC distribution curve from the curve at 10 days. The RBC curve was constructed by the decrease of height of the curve obtained immediately after injection, representing plasma radioiron, using % utilisation figure.

The normal female showed larger erythropoiesis in the pelvic marrow than male. Main part of erythropoiesis was in the chest and pelvic marrow in normal adults. The expansion of marrow to the knee and/or head was observed in severe iron deficiency, hemolytic anemia and polycythemia vera. Partial depression in hypoplasia, radiotherapied, and marked irregularity and defect in myelofibrosis were demonstrated. The progressive increase of depostion of radioiron in the liver of hemochromatosis and hypoplasia and in the spleen of hemolytic anemia was observed in the course of study. Reutilisation of released radioiron by hemolysis not only in severe hemolytic anemias, but also in iron deficiency anemia, inflammation, erythroleukemia, acute myelocytic leukemia, myeloma and etc., was demonstrated as a peak in the pelvic marrow and sometimes in the knee.

Area scan does not show pure erythroid

marrow nor storage in case of poor utilisation, but this method reveals the distribution and amount of pure erythroid marrow and tissue iron respectively in the body section, those are very important for the study of iron metabolism and diagnosis of various hematologic disorders.

Iron Excretion into Gastric Juice

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In an effort to solve the mechanism of iron absorption, a special emphasis was placed on the storage iron content of intestinal mucosa, and as it is believed that the storage iron content of intestinal mucosa affects the iron absorption and iron excess reduces iron absorption, our attention was directed to the iron excretion from gastrointestinal mucosa. First our attention was focused to the gastric juice that can be taken out easily, and non-hemin iron content in gastric juice was examined. The results are as follows.

The iron content in gastric juice was found to be 290 μg/dl in healthy controls, a lower value of 110 μg/dl in aplastic anemia. These values were in a close correlation with serum iron or seideroblasts. Iron content of gastric juice of idiopathic hypochromic anemia was measured at various time intervals after intravenous injection of iron in early morning hours. Subsequently, iron contents of gastric juice clearly increased following intravenous iron administration. These data suggested iron excretion from gastric mucosa.

Radioactive iron appearance in gastric juice was observed clearly after intravenous administration of ^{59}Fe in normal rabbits, indicating iron excretion. The iron content of gastric mucosa was considerably high, and ^{55}Fe appearance was also indicated by radioautography in the epithelium of gastric mucosa. Iron deficiency state due to blood depletion in rabbits, distribution of ^{59}Fe in gastric juice and mucosa was silght. However, in iron excess state due to iron administration it was much higher than in the normal. There is iron absorption in gastric mucosa, and this absorption was marked in iron deficiency and extremely slight in iron excess. No iron excretion in gastric mucosa observed by intravenous ^{59}Fe administration after injection of iron into gastric cavity. On the other hand a increase of radioactive iron in gastric juice by intravenous ^{59}Fe administration was observed due to Desferrioxamine B injection. Similar parallel changes of iron excretion in gastric juice and urine was showed in a case of hemochromatosis injected with Desferrioxamine B. In idiopathic hypochromic anemia a correlation between the iron content and hemoglobin was seen, and this iron content was relatively high when anemia was mild. It is very interesting to note that non-hemin iron of gastric juice at the stage of recovery after iron treatment in idiopathic hypochromic anemia showed a higher value than in the healthy control. Namely, an increase of iron excretion in gastric juice was undoubtedly observed on the recovery of anemia after treatment and this slight excretion of iron during a prolonged period is considered a posibility of the cause of anemia. This condition may be interpreted as an "iron-losing anemia".

In conclusion, iron excretion from gastrointestinal tract especially from gastric mucosa was observed clearly. This iron excretion together with iron absorption may be controled by a single mechanism and sometimes unbalance of this mechanism may be a cause of anemia.