Metabolic Changes of Rat Intestine During Iron Absorption

M. HATTORI and Y. YAWATA

The Third Department of Internal Medicine, Faculty of Medicine, University of Tokyo, Tokyo

The effect of In Vitro and In Vivo iron on the metabolism of rat duodenal tissue was examined by measuring following three parameters: The production of radioactive carbon dioxide ($^{14}$CO$_2$) from C-1 labelled glucose as well as C-6 labelled glucose, the uptake of glucose, and the oxygen consumption.

1) Effect of In Vitro Iron: In Vitro iron administration induced a greater increase in CO$_2$ production from glucose carbon-1 relative to glucose carbon-6. There observed distinct increase of CO$_2$ production from glucose carbon-1 at the iron concentration greater than $5 \times 10^{-5}$M, and the effect was especially prominent at the iron concentration around $2 \sim 5 \times 10^{-4}$M ($2 \sim 4 \times$ of the control). Much lesser increase of CO$_2$ production from glucose carbon-6 was observed. ($1.4 \times$ of the control at most). The stimulatory effects of iron salts were commonly observed at the equimolar concentration ($5 \times 10^{-5}$M) of ferrous citrate, ferrous sulfate, and ferric chloride in almost same magnitude of stimulation.

2) Effect of In Vivo Iron: Ferrous citrate solution (Fe 2.35 mg) was administered by the gastric incubation in the rats, and the metabolic changes of duodenal intestinal slices were examined in groups of rats which were sacrificed at various time intervals after iron administration. The results were as follows: (1) at very early time point (5 min.), there observed a marked stimulation of CO$_2$ production from glucose carbon-1 ($2 \times$ of control) with almost no charge in CO$_2$ production from glucose carbon-6. This early stimulation did not last long, and temporary inert period ensued (1 hr. after iron administration). However, after 2~3 hrs. of iron administration, the second stimulation of CO$_2$ production from glucose carbon-1 as well as from glucose carbon-6 started, and this second phase of stimulation lasted for much longer period (as long as 6 hrs. or more) than the first one. (2) This stimulatory effect of iron salt on the intestinal metabolism was also clearly demonstrated by separate experimental series by measuring uptake of glucose, and oxygen consumption. The time course and the extent of the stimulation were almost identical to the above described experiments using radioactive tracers.

3) Conclusions:

(1) In Vitro iron induced a greater increase of the production of CO$_2$ from glucose carbon-1 relative to the glucose carbon-6. In other words, In Vitro iron caused the activation of the hexose monophosphate shunt of the duodenal tissue slices.

(2) There observed a biphasic stimulation of CO$_2$ production, glucose uptake, and oxygen consumption following the oral iron administration. The early phase of stimulation was characterized by its temporary nature and also by the almost exclusive activation of the pentose cycle of the duodenal tissue, and the second stimulation, which was characterized by the concomitant increase of CO$_2$ production from glucose carbon-1 as well as from carbon-6, was followed after the brief inert period.

(3) These results were considered to suggest a system of relatively low energy dependence plays an important role in the early phase of the intestinal iron absorption.