

Absorption of Iron Compounds from the Upper Part of the Small Intestine.

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The intubation technique of Miller and Abbott^{1, 2, 3} as modified by Groen⁴ has been used in the present investigation to study the absorption of ferrous, ferric, and complex iron compounds from a 50 cm. loop of the small intestine in man.

Each iron salt after being dissolved in 100 ml. of distilled water was introduced into the isolated segment of gut of a fasting subject in such amounts that between 80 and 100 mg. of iron were present.

After 30 minutes the solution was aspirated and washing of both the blocked segment of intestine and the stomach was commenced and was continued for 30 minutes.

Aliquot amounts of both intestinal contents and washings were analyzed for total iron by the method of Taylor and Brock.⁶ When the intestinal contents contained organic debris of a nature that made accurate sampling impossible, the intestinal contents were partially digested by standing for 48 hours after mixing with an equal volume of concentrated sulphuric acid.

With ferric salts (ferric ammonium sulphate, ferric chloride and ferric nitrate) 20 to 35% of the iron was recovered. With the ferrous salts (ferrous sulphate, ferrous ammonium sulphate and ferrous chloride) 60 to 76% of the iron administered was recovered. With ferric ammonium citrate 100% was recovered. Dr. Wilfrid Owles¹¹ in this laboratory, using a 3-lumen tube and a completely isolated segment of intestine, obtained similar recoveries for ferrous sulphate and ferric ammonium citrate, while Abbott and Miller reported³ 100% recovery with ferric ammonium citrate. If the difference between the amount of iron ingested and that recovered, were assumed to be the amount absorbed, the conclusion would be

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¹ Miller, T. G., and Abbott, W. O., *Am. J. Med. Sci.*, 1934, **187**, 595.

² Miller, T. G., and Abbott, W. O., *Ann. Int. Med.*, 1934, **8**, 85.

³ Miller, T. G., and Abbott, W. O., *J. A. M. A.*, 1936, **106**, 16.

⁴ Groen, Juda, *J. Clin. Invest.*, 1937, **16**, 245.

⁵ Brock, J. F., and Taylor, F. H. L., *Biochem. J.*, 1934, **28**, 447.

⁶ Taylor, F. H. L., and Brock, J. F., *Biochem. J.*, 1934, **28**, 442.

¹¹ Owles, W. H., personal communication.

that ferric salts were better absorbed than ferrous salts and that ferric ammonium citrate was not absorbed at all. This conclusion is obviously at variance with clinical observations on patients suffering from achlorhydria and anemia due to iron deficiency.⁷⁻¹⁰

The possibility that the discrepancy between the amount of iron administered and that recovered might be explained by adsorption of the iron compound on the mucous lining of the intestine was checked by a second series of observations. The technique employed was the same except that following the 30-minute period allowed for absorption washing was continued for periods up to 3½ hours. The washings for each half hour were collected and separately analyzed for iron. It was found that the intestine slowly yielded up additional amounts of iron. These additional amounts of iron coincided with the appearance in the washings of particles and filaments of rusty brown colored mucus, which were rich in iron. When the washings were continued for 3½ hours 100% of all forms of iron were recovered. It appeared that the highly ionizable iron salts entered into combination or were adsorbed by the mucus, while ferric ammonium citrate possessing little "astringent" properties was not.

Heath, *et al.*,¹² have shown that, when iron is given with mucin to patients with hypochromic anemia, there is inhibition of the response of the patient's blood. We thus mixed iron salts with commercial mucin prior to administration so that interaction with the protein could take place. When this was done the recovery of iron was quantitative after 30 minutes of washing. These experiments would suggest that the apparent absorption obtained by Owles and ourselves and also by Miller and Abbott³ was actually due to adsorption on the mucus of the intestinal tract.

⁷ Heath, C. W., Strauss, M. B., and Castle, W. B., *J. Clin. Invest.*, 1932, **11**, 1293.

⁸ Witts, L. J., and Manch, M. D., *Lancet*, 1936, **1**, 1.

⁹ Witts, L. J., and Davidson, L. S. P., *Proc. Roy. Soc. Med.*, 1933, **76**, 607.

¹⁰ Davidson, L. S. P., Fullerton, H. W., and Campbell, R. M., *Brit. Med. J.*, 1935, **11**, 195.

¹² Heath, C. W., Alsted, G., Pohle, F. J., and Minot, G. R., *personal communication*.