Is Hydrochloric Acid Secreted by the Mucous Membrane of the Stomach?

BY

J. A. WESENER, Ph.C., M.D.

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IS HYDROCHLORIC ACID SECRETED BY THE MUCOUS MEMBRANE OF THE STOMACH?

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In the *Journal of the American Medical Association* of March 2, 1895, Dr. Faulkner makes the statement that hydrochloric acid is formed by the action of lactic acid upon salt; that the gastric juice always contains salt after a test meal; that lactic acid is also present, and that when concentrated and treated with Gunzbürg's reagent it gives a reaction for hydrochloric acid. He performed a great many of these experiments with different organic acids and salt, and all responded to the hydrochloric acid test; furthermore he states that hydrochloric acid is not found in the stomach, and if present would seriously injure that organ.

According to Ewald, the ideal treatment in chronic gastritis is large doses of dilute hydrochloric acid in as concentrated form as the patient can tolerate. I have had the same experience in these cases giving thirty drops of the dilute acid three times daily. It has seemed to benefit the patients immediately, and to stop fermentation without injuring the stomach.

Recent researches have shown that lactic acid is not the normal acid of the stomach. C. Schmidt was the first to show that hydrochloric was the normal acid. At that time the presence of lactic acid was explained as a product of fermentation—Miller found in the stomach and mouth a number of bacteria that had the property of changing sugar into lactic acid. This would lead to a possible conclusion that lactic acid may be a normal product of gastric digestion. Experiments performed in this direction gave positive results with Uffelmann's reagent; but later it was shown that this test was not reliable, as similar reactions were obtained with lactates, phosphates, and sugar. Lactic acid in solution with the normal percentage of HCl found in the gastric juice gives no reaction, or a greatly diminished one, with Uffelmann's test.

On the other hand, Rosenheim claimed that lactic acid fermentation was always the end product of digestion, notwithstanding that his results were negative with the Ewald-Boas test meal. His explanation was that the reaction was hidden by the presence of hydrochloric acid; furthermore he claimed that lactic acid was a normal product of carbohydrate digestion. Cahn and V. Merring express themselves in

the same way, but not so positively; Leo also holds the same view. In 1892, Kurzen, Von Martin, and Luttke, in their interesting monograph *Die Magensaüre des Menschens* (Stuttgart, 1894), found by analysis that the quantity of free HCl coincided with the curve of total acidity. This work, if accurate, is in itself most positive proof that HCl is the normal acid of the stomach.

Since then Boas' work on this subject proves beyond the slightest doubt that lactic acid is not formed during digestion, and the test used is reliable. Richet has shown in his researches that under normal conditions the stomach contains but one acid, and that is hydrochloric.

I have repeated Dr. Faulkner's experiments showing that salt in the presence of organic acids and Gunzbürg's reagent, when evaporated to dryness, gives a test for hydrochloric acid. The concentration liberates some of the chlorine of the salt, which combines with the hydrogen of the lactic acid to form hydrochloric acid.

The same experiments were made with Boas' reagent, and all gave negative results. A 1-per-cent. and a 5-per-cent. solution of common salt, and a 3-per-cent. and also a 6-per-cent. solution of lactic acid, were used. One drop of the 5-per-cent. salt solution with one of 3-per-cent. lactic acid solution, *plus* two drops of Boas' reagent, were carefully evaporated over a water bath; results for hydrochloric acid negative. The same results were obtained with the stronger salt and acid solutions.

Gunzbürg's reagent gave a reaction with both of these solutions. The only explanation that can be given, why Gunzbürg's gives a positive reaction and Boas' a negative one, is that in the latter the sugar protects the salt from the action of the acid. Several experiments of the same nature were tried with gastric juice rich in organic acids. Two to three drops of gastric juice, mixed with salt solution and Boas' reagent, gave negative results. The analysis in one case after Ewald's test meal gave a slight reaction for HCl, but this when handled as above gave no HCl reaction.

According to Ewald, Boas' reagent is just as delicate as Gunzbürg's, and therefore is always to be preferred—for the reasons already given.

EXPERIMENT I.

Case A. Age, 24; diagnosis, dilatation of the stomach of one year's duration. Analysis of stomach contents after Ewald's test meal gave a total acidity of 70, and of lactic acid a slight trace. The patient was ordered to appear at the Clinic with an empty stomach (ten hours after taking a meal), when it was found on examination that the stomach was not empty. The stomach contents were tested

for hydrochloric acid with Boas' reagent and found to be negative. The stomach was thoroughly washed with hydrant water and the last of the washing tested for hydrochloric acid, with negative results. The gyromele was then introduced and rapidly revolved for two minutes, and the stomach contents withdrawn and tested. Boas' reagent gave a positive reaction. The quantitative estimation for free hydrochloric acid was done as follows: 5 Cc. of filtered contents, *plus* silver nitrate and strong nitric acid, precipitated all the chlorine as silver chloride; the precipitate was collected on a paper of known ash, washed with distilled water until the reaction for silver disappeared, and then dried in the oven, ignited in a crucible, and a few drops of hydrochloric acid added to convert the reduced silver back to silver chloride. The crucible was cooled over sulphuric acid and weighed as silver chloride; this weight equals the combined chlorides and free hydrochloric acid in 5 Cc. of gastric contents, and multiplied by 20 gives the percentage of silver chloride. From this answer the per cent. of total chlorine was found to be 0.155. The next step in the operation was to estimate the combined chlorides: 5 Cc. of stomach contents were evaporated to dryness over a water bath (this drives off all of the hydrochloric acid), the residue redissolved in distilled water, silver nitrate and nitric acid added, and then the experiment was carried out the same as in the above analysis. This gave 0.0027 as the weight of the combined chlorine in the 5 Cc. of gastric contents; 100 Cc. of stomach contents would thus contain 0.054 of combined chlorine. This deducted from the above answer (of combined chlorides and free hydrochloric acid), leaves the chlorine combined with hydrogen: $0.155 - 0.054 = .101$ of free chlorine; or .103 of free HCl.

Case B. (Dr. Turck's Post-Graduate Clinic.) Age, 51; diagnosis, *gastritis glandularis chronica*, with beginning atrophy. At the outset of treatment there was no HCl, no rennet, and only a slight peptone reaction. At the end of four months the empty stomach was thoroughly cleansed with hydrant water, the gyromele* introduced and revolved three minutes, the contents withdrawn and tested as above. The amount of HCl found was 0.106; combined chlorides, 0.059.

Case C. (Dr. Turck's Post-Graduate Clinic.) Normal stomach experiment conducted same as in A and B. Distilled water instead of lake water used to wash; the last washing tested for chlorine with silver nitrate was negative. The amount of HCl in 100 Cc. was 0.099; combined chlorides, 0.0024. The use of distilled water accounts for the low percentage of combined chlorides.

*Turck's gyromele consists of a steel cable, to which is attached a spiral covered with sponge; the cable passes through a stomach-tube and is then attached to a surgical drill; turning the drill revolves the cable.

A control analysis was made of same contents: 5 Cc., *plus* 5 Cc. of saturated solution sodium carbonate, were evaporated to dryness and gently fused; the residue dissolved in distilled water; nitric acid and silver nitrate added; the precipitate of silver chloride collected upon a filter of known ash, washed with distilled water, and then handled the same as in Case A. The result gave 0.08 of chlorine. Another 5 Cc. of the same gastric juice was first evaporated to dryness (thus driving off all free hydrochloric acid); 5 Cc. of sodium carbonate solution added and gently charred; the residue redissolved in distilled water; nitric acid and nitrate of silver added; and the process then carried out as above. The combined chlorides, .0018, subtracted from total chlorine (.08 – .0018) = .0782 chlorine combined with hydrogen, which would be .081 of free HCl—.018 less of HCl than was found in the original analysis. This slight error is due no doubt to the fusion.

As the stomachs examined were demonstrated to be entirely free from HCl, and no food was taken, and as HCl was undoubtedly present after brushing, there is no other conclusion possible but that the acid was secreted by the stomach. Again I wish to emphasize that Boas' reagent does not give HCl when present only from decomposition.

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