A Comparison between Intragastric Titration and Aspiration Technique under Basal Conditions and after Food or Pentagastrin Stimulation

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A total of 16 healthy subjects had gastric secretory studies where acid was either measured by the conventional aspiration technique (AT) or by intragastric titration at a pH of 5.0 (IT). In a first study food- and pentagastrin-stimulated PAO levels, both measured by IT, were within similar ranges. However, as compared to the respective AT data of the same subjects, the mean IT results were 35% higher, although both values were well correlated. In a second study a similar difference was observed between IT and AT data throughout the whole range of the pentagastrin dose-response curve. Both curves followed Michaelis–Menten kinetics and had similar $K_m$ values, while $V_{max}$ values were significantly higher at IT. This constellation excludes an increase of the gastrin sensitivity of the parietal cells as a cause for the higher IT data. It is, however, in keeping with the hypothesis that the distension stimulus present at IT potentiates the pentagastrin-stimulated acid secretion. It is likely that methodological problems such as overtitration of acid at IT and transpyloric loss of acid at AT additively contribute to the relatively large difference between AT and IT values. It is therefore not possible to fully interchange AT and IT data, despite their good correlation.

Intragastric titration (IT) was initially used to assess gastric acid secretion by a telemetric pH capsule (1-4). More recently Fordtran and Walsh (5) developed a technique to determine food-stimulated gastric acid secretion by IT. The latter method has been successfully used to study the effects of gastrointestinal hormones and other substances on food-stimulated acid secretion in man and experimental animals (5-20). IT offers the advantage of continuously monitoring acid secretion, which facilitates the assessment of the intragastric response to drugs that stimulate or inhibit acid secretion. To further validate this technique it was, however, considered important to correlate acid secretion as measured by IT with the conventional aspiration technique (AT) under basal conditions or after food or parenteral pentagastrin administration.

MATERIALS AND METHODS

The investigations were performed on a total of 16 healthy students, 23–29 years of age, with no history of dyspepsia and who gave informed consent. All tests were started at 0800 hr after a minimum fast of 10 hr. Using conventional AT, a radiopaque 16-Fr. Levine gastric tube was introduced into the most dependent part of the stomach and its position checked fluoroscopically. Fasting juice was discarded and secretions were then collected using intermittent pump aspiration and additional manual aspiration at 5-min intervals. The poor correlation of "basal" AT and IT prompted us to change the AT in
study II to manual aspiration alone with 2–3 aspirations per 5-min interval. Acid was measured by titration with 0.05 M NaOH to pH 7.4, using a Radiometer automatic titrator and Radiometer autoburette.

Intragastric titration was performed as a modification of the Fordtran and Walsh technique (5) monitoring intragastric pH and using the “pH stat” principle similar to the technique described by Konturek et al (6). After calibrating with two buffer solutions at pH 4.0 and 7.0 at 37°C, a net shielded Radiometer glass calomel electrode (GK 282 C) was introduced into the stomach via the oral route. This was followed by oral introduction of a 16-Fr. Levine-type gastric tube to which a polyvinyl tube with a 1-mm diameter had been glued so that the open end was fixed 8 cm proximal to its tip (Figure 1). The whole tube assembly was then positioned fluoroscopically so that the tip of the Levine tube was located in the distal gastric body, some 2 cm proximal to the tip of the shielded electrode. During the tests the subjects were put in the left lateral position and the foot end of the couch was elevated 25 cm. Fasting juice was then aspirated through the Levine tube and discarded and 50 ml of 0.15 M sodium chloride at pH 5.0 was instilled. To ensure mixing, the gastric contents were continuously aspirated and reintroduced into the stomach, 2–4 times/min, using a 20-ml plastic syringe. The pH probe was connected to a titrator (TTT2 Radiometer) and the polyvinyl tube to an ABU 12 Radiometer autoburette. The pH was set at 5.0, and the volume of 0.3 M NaHCO₃ instilled to keep the pH constant was continuously recorded on a Radiometer REA 300 recorder. The connection between the Levine tube and aspiration syringe was frequently released to let the CO₂ gas escape. When intragastric pH remained low in spite of constant inflow of the titrant, the positions of the subjects were changed and samples of less than 5 ml of gastric juice were aspirated to compare intra- and extragastric pH readings. A total of 464 such tests were made. This manœuvre was performed to avoid recording false high acid levels as a consequence of inadequate mixing of gastric acid and titrant.

**Conventional Pentagastrin Test (Test I)**

After the fasting juice was discarded, basal acid secretion was collected for two 30-min periods (BAO). Pentagastrin (Peptavlon, I.C.I., Macclesfield, Cheshire, England) at a dosage of 6 μg/kg was then injected subcutaneously and acid collected for 4 15-min periods. The acid produced was expressed as the 1 hr MAO and as PAO values (highest two consecutive 15-min values ×2). This test was performed on 9 subjects.

**Pentagastrin Test with IT (Test II)**

Similar test to I, but measuring BAO, MAO, and PAO by IT. The same subjects were studied as in test I, and the order of tests was randomized.

**Meat Extract Test (Test III)**

After discarding the fasting juice, 50 ml of 0.15 M sodium chloride was introduced into the stomach and “basal” acid secretion studied for 1 hr by IT. Five hundred milliliters of 10% meat extract (Liebig, Germany) made up at pH 5.0 and 37°C was introduced into the stomach and acid determined by IT. Total 3-hr acid output and PAO values were determined. This test was performed on 7 out of the 9 subjects submitted to tests I and II.

**Study II**

In this study the pentagastrin dose-response relationship was studied in 6 healthy subjects both at AT and IT on different days. None of these volunteers had been studied in study I. The order of tests was randomized. Pentagastrin was given by continuous intravenous infusion through an indwelling catheter into a forearm vein, using an infusion pump (Perpex, Switzerland). Five doses were used, the dosage being quadrupled every 30 min from 0.0234 to 6 μg/kg/hr. The last 20-min sample of every 30 min period was used for calculation.

**Statistical Evaluation of Data**

The individual values obtained with AT or IT were correlated and the data compared using paired t test analysis. In study II the results of the dose-response curves were subjected to Michaelis–Menten kinetic analysis and linear transformation was obtained when using Dowd–Riggs equation (20).

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V = V_{max} - K_m \left( \frac{V}{D} \right)
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\(K_m\) and \(V_{max}\) were calculated for actually measured values and for basal corrected data (21), the mean values for \(K_m\) and \(V_{max}\) being taken as means of individual results or as mean values of group data.

**RESULTS**

Extragastric pH measurement performed during IT to assess the accuracy of gastric mixing revealed a pH of > 5.5 in 95 of our 372 measurements (34.2%) in study I and 13 out of 92 (14.1%) (P < 0.001 using χ² test) in study II.

**Study I**

“Basal” acid measurements by IT were initially found to be difficult and resulted in dis-