Fate of Antacid Gel in the Stomach
Site of Action and Interaction with Food

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The site of action of a high-power Al-Mg antacid gel (buffering capacity 70 meq/10 ml)
and its interaction with food was examined in 10 healthy volunteers. Combined pH-
metries in antrum and corpus were performed in each volunteer on four occasions. In a
randomized study design, antacid or placebo were given 1 hr after either a protein or a
carbohydrate pancake, of which only the former had any acid-buffering capacity. Before
the meal, pH was higher in the antrum than in the corpus (median antrum: 3.2, corpus
1.5). In the corpus, a protein pancake but not a carbohydrate pancake raised the pH
(median pH after protein pancake: 3.5; after carbohydrate pancake: 1.4). In the antrum,
the protein pancake had no effect, but the carbohydrate pancake decreased the pH
(median pH after protein pancake: 3.1; after carbohydrate pancake: 2.0). The antacid had
no effect in the corpus after either pancake. It raised intraluminal pH markedly in the
antrum after a carbohydrate pancake (median antral pH before antacid: 2.0; after
antacid: 3.3), whereas its effect in the antrum was weak after a protein pancake. In vitro
experiments were conducted to explain the in vivo results: in contrast to a carbohydrate
pancake, a protein pancake reduced the buffering capacity of the antacid by direct
interaction. In conclusion, the effect of an antacid gel on intragastric pH is predominantly
localized in the antrum and is attenuated in the presence of proteins. Thus, pancakes of
differing compositions may be used, in conjunction with pH-metry in the antrum and the
corpus, to study functional gastric compartmentalization and to quantify and localize
antacid effects and food interactions.

KEY WORDS: antacid; intragastric acidity; carbohydrate; protein; gastric emptying.
action of antacids because they transform the stomach into an uniform mixing chamber. There is now evidence from double pH-metry studies that the gastric antrum and corpus are functionally distinct compartments that maintain different pH values during fasting and feeding (5). Furthermore, we have also found, in single pH-metry studies, that antacid gels have little effect on luminal pH in the corpus (6). There are two possible explanations for this finding: either antacid gels are ineffective or their primary site of action is the antrum. If the latter is true, then the presence of food in the corpus postprandially might be expected to interfere with this, either by preventing transfer of the antacid from the corpus to the antrum or by interacting directly with antacid. Moreover, it might be expected that foods of different composition would have different effects on antacid activity either by a direct interaction, by virtue of their intrinsic buffering capacity, or by affecting gastric motility and secretion. We therefore created two hypotheses to be tested: first, that antacid gels act primarily in the antrum and second, that a protein meal, by virtue of its high intrinsic buffering capacity, would further increase the buffering effect of an antacid gel in the antrum. These hypotheses were tested by performing gastric double pH-metry to assess the effect of high-protein food or protein-free food, with subsequent antacid gel ingestion, on luminal pH in the antrum and the corpus of volunteers.

MATERIALS AND METHODS

In Vivo Studies

Volunteers. The study was performed in 10 healthy volunteers. They were members of the hospital staff and had participated in several previous studies involving pH-metry. Five of the volunteers were males and five were females. Their median body weight was 62 kg (range 45–75), and their median age was 24 years (range 20–30). Three of the volunteers were smokers; they did not smoke during the examinations (0800–1600 hr). None of the volunteers had a history of gastrointestinal diseases and none was taking drugs. Informed consent was given, and the trial was approved by the hospital ethics committee.

Experimental Design. Four pH-metries were performed in randomized order in each volunteer on four separate days at least one week apart. A Latin square design, using either a protein pancake or a carbohydrate pancake, and high-power liquid Al-Mg antacid (10 ml, Maalox, Rorer) or placebo (10 ml) was employed. On each study day the volunteers fasted after a standard breakfast at 0800 hr (100 g bread, 20 g butter, 40 g cheese, and 40 g ham), before coming to the laboratory at 1000 hr when two gastric pH electrodes were introduced transnasally; pH was recorded between 1130 and 1630 hr. From 1200 to 1215 hr, the volunteers ate a pancake and drank 150 ml of tap water; at 1300 hr, the antacid gel or placebo was given. In six consecutive volunteers, gastric emptying was measured between 1200 and 1600 hr during the placebo studies, which were otherwise identical to those studies in which antacids were given.

Pancakes. The chemical composition, mean weight, and energy content of the pancakes is given in Table 1. Dough for protein pancakes was produced by mixing one egg, 52 g protein powder (Dr. Ritters Eiweiss 2000, Dr. Ritter, Köln, FRG), 8.0 ml sunflower oil (Morga AG, Ebnat-Kappel, Switzerland), 1.5 yeast (dry yeast, Dr. Oettker, Hannover, FRG), 4.0 g artificial flavoring (Aromat, Knorr, Thayngen, Switzerland), 0.5 g NaCl, and 80 ml water, and, for gastric emptying studies, 100 μCi 99mTc. Dough for carbohydrate pancakes was produced by using 60 g flour (protein-free Damin, Maizena, Heilbronn, FRG), instead of the egg and the protein powder. The dough was baked in aluminum pans at 170° C for 30–40 min in an electric oven. The two types of pancakes were similar in appearance, taste, and consistency. The pancakes were cut into pieces of 4–6 cm²; the volunteers were instructed to chew them slowly and to finish the pancake within 15 min.

Stability of radiolabeling was tested in vitro as follows: labeled pancakes were chewed and spat into 300 ml of artificial gastric juice (3.2 g pepsin, 80 ml 1 N hydrochloric acid, 3.0 g NaCl, and 1000 ml distilled water); the mixture was agitated and the concentration of 99mTcDTPA was determined in both solid and liquid phases every 10 min for 3 hr. Twenty minutes after incubation of a protein pancake and a carbohydrate pancake, 17% ± 4% and 19% ± 3% (means ± SD) of 99mTc, respectively, were found in the liquid phase. During a subsequent 3-hr incubation period, the concentrations of free label remained constant.

pH Monitoring. pH monitoring was performed as described previously (5–8) using two miniaturized combined glass electrodes (model 440 M4, Dr. Ingold AG, Urdorf, Switzerland, electrode diameter 4 mm).

Calibration. Calibration of the electrode was performed at room temperature using commercial buffer solutions at pH 7.00 and pH 1.69 (Dr. Ingold AG) at the beginning and end of each test. Temperature correction was performed automatically by the recorder.

<table>
<thead>
<tr>
<th>Table 1. Composition of Standardized Pancakes</th>
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<tr>
<td>Carbohydrate pancake</td>
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<tr>
<td>Protein (g)</td>
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<tr>
<td>Carbohydrate (g)</td>
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<tr>
<td>Fat (g)</td>
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<tr>
<td>NaCl (g)</td>
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<tr>
<td>Water (ml)</td>
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<tr>
<td>Energy content (kJ)</td>
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<tr>
<td>Weight after baking (g ± sd)</td>
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<td>Label* (μCi [99mTc]DTP)</td>
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*Label was only used in gastric emptying studies.