Basal and Pentagastrin-Stimulated Acid Secretion in Newborn Human Infants

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Summary

Basal and pentagastrin-stimulated gastric acid secretion was measured in 26 healthy newborn infants on the 1st and 2nd days of life. Basal acid outputs (BAO) on day 1 (0.378 mEq/hr) and day 2 (0.388 mEq/hr) were similar and not significantly different from the maximal acid outputs (MAO) on day 1 (0.413 mEq/hr) and day 2 (0.452 mEq/hr). When calculated on a mEq/kg/hr basis, BAO on day 1 was 0.110 with an MAO of 0.122. The BAO on day 2 was 0.114 with an MAO of 0.133. Fasting serum gastrin levels obtained before the acid studies on each day were elevated (mean, day 1 = 100 pg/ml; mean, day 2 = 108 pg/ml). These findings suggest that either gastric acid secretion in the newborn is maximal under basal condition or that newborn parietal cells are unresponsive to pentagastrin on day 1 and 2 of life.

It has been well established that newborn human infants have an intragastric pH which ranges from 5.5 to 7.0 and that this pH decreases during the first hours of life (2, 9, 10, 13). A number of studies have found increased gastrin levels in umbilical cord blood, but in a previous study we have documented that, although serum gastrin levels remain elevated until at least 8 hr of age, the secretion of gastric acid in response to this stimulant is less than expected (4-6, 15). Therefore, the objectives of our present investigation were the following: 1) measurement of the rate of BAO on day 1 and 2 of life to determine if any change occurred with increasing age; 2) measurement of MAO on days 1 and 2 of life to determine parietal cell responsiveness to pentagastrin; and 3) measurement of fasting serum gastrin values to determine whether any change occurred with increasing age.

MATERIALS AND METHODS

This investigation was approved by the Human Experimental Investigative Committee of Harbor General Hospital, Torrance, CA. Informed parenteral consent was obtained before the start of each study.

Twenty-six infants were studied (14 males, 12 females). All were the products of full-term uncomplicated gestations, labors, and vaginal deliveries. All Apgar scores were within normal limits and the newborns' weights range from 2523-4130 g (mean = 3345 g). All infants were examined before each study by one of the investigators (A. R. E. or W. J. B.) and their physical examinations were normal. After a 4-hr fast, each infant had the following done on day 1 and 24 hr later on day 2: 1) venous blood sample for gastrin, 2) BAO, and 3) MAO after pentagastrin stimulation.

All infants studied were older than 8 hr at the time of initial acid studies. The blood sample was obtained before the start of the acid studies on each day. Serum gastrin levels were determined in duplicate by radioimmunoassay by a method previously reported (17).

After the blood sample was obtained, a nasogastric tube was passed and the infant was placed in the left lateral position with

the foot of the crib slightly elevated. Fifteen milliliters of distilled water was placed into the stomach and the tube was positioned where all of the water could be removed. Suction was then started via a Stedman Model 2590 suction pump (American Cytoscope Maker, Inc., New York, NY), and a continuous negative pressure of 3-5 cm H₂O maintained throughout the study. Frequent interruptions of machine suction and manually applied pressure documented tube patency. All gastric samples were collected in 15-min aliquots and kept refrigerated until acidity was measured.

The first 15-min aliquot, after suction was started, was discarded. The next four 15-min aliquots comprised the BAO collection period.

After the 1-hr basal collection period, pentagastrin (Peptavolon: Ayerst Labs, New York, NY) was given subcutaneously (dose, 2 µg/kg). The first six infants in our study received a pentagastrin dosage of 6 µg/kg. The acid secretory response to this injection was similar to that found when a dosage of 2 µg/kg was used in the next six infants. In the remaining infants in our study the latter dosage of pentagastrin was used.

Gastric secretions were then collected for 1 hr after this injection. Initially, gastric secretions were collected for 2 hr after the pentagastrin injection, but we found that, if an acid secretory response to this stimulation occurred, it happened within the first 60 min (mean = 30 min).

The volume, pH, and hydrogen ion concentration of each sample was measured by titration to pH 7.0 using a Radiometer PHM63 digital pH meter with a TTT60 titrator and ABU13 autoburette (Radiometer, Copenhagen, Denmark) (16). MAO and BAO equalled the sum of the hydrogen ion concentrations in each of the four 15-min aliquots in their respective 1-hr collections.

The following statistical methods were used to analyze the data: 1) Student's *t*-test for unpaired means, 2) linear regression analysis, and 3) one factor analysis of variance.

RESULTS

The volume of basal acid secretions on day 1 (mean = 7.0 ml/hr) and day 2 (mean = 6.9 ml/hr) were similar to the volumes secreted after stimulation on the same days (5.8 ml/hr and 5.3 ml/hr). The mean pH for the basal periods (day 1 = 3.06, day 2 = 3.12) was not significantly different from those found after pentagastrin stimulation (day 1 = 2.97, day 2 = 3.05).

The results of the BAO and MAO for our 26 newborns are shown in Table 1. Statistical analysis reveals no significant difference between the BAOs or MAOs on either day. Also, no correlation was found between: 1) BAO, MAO, or serum gastrin and birth weight; and 2) BAO or MAO and serum gastrin.

Table 2 shows the results of BAO and MAO in the same patients when calculations were made on a milliequivalent per kilogram per hours basis.

The serum gastrins found are listed in Table 1. For comparison the mean for normal adult patients in our laboratory is included. The newborns' serum gastrin is significantly higher (*P* < 0.005) than adults but the values on day 1 and 2 are similar.

Table 1. BAO, MAO, and mean fasting serum gastrin on day 1 and day 2 of life in 26 newborn human infants (mean $\pm$ SEM)

	Day 1	Day 2
Acid secretion (mEq/hr)		
BAO	0.378 $\pm$ 0.060	0.388 $\pm$ 0.053
MAO	0.413 $\pm$ 0.053	0.452 $\pm$ 0.065
Serum gastrin (pg/ml)		
Newborns	100 $\pm$ 13	108 $\pm$ 10
Adults	49 $\pm$ 3.2	

Table 2. BAO and MAO calculated on a mEq/kg/hr basis in 26 newborn infants on day 1 and day 2 of life (mean $\pm$ SEM)

	Day 1	Day 2	Christie <i>et al.</i> ¹	Lari <i>et al.</i> ²
BAO	0.110 $\pm$ 0.016	0.114 $\pm$ 0.014	0.035 $\pm$ 0.010	0.050
MAO	0.122 $\pm$ 0.015	0.133 $\pm$ 0.018	0.248 $\pm$ 0.040	0.221

¹ Christie *et al.* study (3): 14 patients, age range 5 months to 17 years (mean age = 12.1 years).

² Lari *et al.* study (12): 10 patients, age range 3 to 31 months (mean age = 11.7 months).

Before the start of the fasting period on day 1, 12 infants had received one feeding of glucose water. The BAO, MAO, and serum gastrin levels in these patients were similar to those newborns not fed before the study on day 1. On day 2, 6 infants were being breast fed, and 20 infants were on commercial formula feedings. There also was no significant difference between these two groups.

During this investigation there was no morbidity or mortality associated with the basal or pentagastrin-stimulated acid secretory studies.

DISCUSSION

Although gastric acid secretory studies in pediatric age patients have been reported, most have not included systematic evaluations of newborns nor included BAOs or MAOs (1, 3, 8, 11, 12, 14). Agunoud *et al.* (1) reported on 10 newborns studied during the 1st day of life, but no BAOs or duration of fasting were given, and a different stimulant, Histalog, was used. The acid secretory response after stimulation (mean = 0.01 mEq/kg/hr) was significantly less than the values that we found basally or after pentagastrin stimulation. The reasons for this are not apparent.

The investigation reported by Lari *et al.* (12) is the only one to our knowledge using pentagastrin in children. That study differed from ours in that it did not include newborns, had a shorter BAO period (30 min), and the infants were fasted for 8–10 hr. Our newborns' BAOs on day 1 (0.110) and day 2 (0.122) were higher than those in this study. The difference in our period of fasting (4 hr vs. 8 hr) or difference in age of our patients (1 or 2 days vs. 30 days to 1 year) may account for the different values found. The acid secretory response to pentagastrin in that study (12) and to Histalog in the study by Christie (3, 18) are much higher than our newborns' response to pentagastrin on either day. The values are shown in Table 2. Besides the differences already mentioned, it may be that newborns are maximally stimulated under the basal conditions of our study. Other explanations include the possibility that newborns do not have a mature receptor on their parietal cells for gastrin or that the gastrin molecule present may not be the most active biological form for parietal cell stimulation. This

latter hypothesis is supported by the knowledge that newborns who are fasted for 8 hr after birth still have high gastrin levels and yet produce less acid than would be expected (6). Also it is known that newborn piglets' parietal cells produce acid in response to histamine but not gastrin stimulation, indicating that an immature receptor site is present in this species inasmuch as older animals do respond to gastrin (7). The reasons for the variance in basal acid secretion between our previous and present study are unknown. One possible factor is the difference in age between our two study populations inasmuch as the infants in our previous group were all less than 9 hr old.

CONCLUSION

In our present investigation, we have documented the following: 1) newborn human infants have a relatively high BAO after 8 hr of age on day 1 and day 2 of life; 2) newborns' BAO is not significantly stimulated further by pentagastrin on either of these days; and 3) newborns have a high serum gastrin level after a 4-hr fast on both day 1 and day 2.

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