Effect of long-term parenteral feeding on gastric secretion in dogs

PIOTR J. THOR, EDWARD M. COPELAND, STANLEY J. DUDRICK, AND LEONARD R. JOHNSON

Departments of Physiology and Surgery, The University of Texas Medical School, and Department of Experimental Surgery, The University of Texas Systems Cancer Center, M. D. Anderson Tumor Hospital and Tumor Institute, Houston, Texas 77030

THOR, PIOTR J., EDWARD M. COPELAND, STANLEY J. DUDRICK, AND LEONARD R. JOHNSON. Effect of long-term parenteral feeding on gastric secretion in dogs. Am. J. Physiol. 233(11): E39-E43, 1977 or Am. J. Physiol.: Endocrinol. Metab. Gastrointest. Physiol. 1(1): E39-E43, 1977. Three dogs were surgically prepared with gastric fistulas and Heidenhain (vagally denervated) pouches. Acid and pepsin output from the denervated pouch in response to pentagastrin and food were determined before, at the end of a 1-mo period of total parenteral feeding, and 1 mo after the resumption of a normal oral diet. Acid and pepsin output from the denervated pouch in response to pentagastrin and food decreased significantly (P < 0.001) after parenteral feeding and returned to control levels after the dogs resumed a normal diet. Secretory outputs from the gastric fistula in response to pentagastrin remained unchanged throughout the experiment. Basal serum gastrin levels decreased 50% during the period of intravenous feeding and returned to levels approximately twice the control levels following resumption of normal oral food intake. Serum gastrin responses to a meal also decreased during intravenous alimentation and returned to higher than normal levels following a 1-mo period of oral intake. These studies indicate that the absence of oral food intake in the dog does not result in decreased acid secretion from the innervated stomach. Vagal innervation in some way is responsible for the preservation of normal secretion during the absence of food from the gastrointestinal tract of the dog.

METHOD

Experiments were performed on three male dogs weighing 15-19 kg. Each dog was anesthetized with thiopental sodium, 20 mg/kg, and methoxyflurane. A laparotomy was performed under aseptic conditions and a vagally denervated pouch (Heidenhain type) was constructed from the oxyntic gland area of the stomach. The pouch was drained to the outside through a Gregory cannula. A gastric fistula was created by inserting a Thomas cannula in the most dependent portion of the gastric remnant.

The animals were supported by slings and trained to stand quietly on tables. Experiments began 3 wk following surgery. A peripheral leg vein was cannulated and saline infused via a Harvard peristaltic pump at a rate of 1 ml/min. The gastric fistula was opened and both the main stomach and denervated pouch were washed gently with distilled water and allowed to drain. Basal secretion from both the Heidenhain pouch and gastric fistula was collected for two 15-min periods.

Two types of studies were performed. In one series, pentagastrin (Imperial Chemical Industries) was infused in doses increasing in a stepwise manner of 0.5, 1.0, 2.0, and 4.0 μg/kg per h. Each dose was infused for three 15-min collection periods. In the other study, one can of dog food (Prescription Diet Riviano Foods, Hill’s Division, Topeka, Kans.) was fed following the collection of basal secretion. Gastric juice was collected at 15-min intervals for 3 h following feeding. The food was entirely consumed in each instance within a few minutes of presentation. Blood samples for serum gastrin assays were collected at the end of the basal period and at 30 and 60 min following eating. Two experiments of each type were run on each of the three dogs, so all mean values reported are from six observations.

The volume of each secretory sample was measured...
The weights of the animals remained relatively constant following resumption of oral food intake. Secretory data are expressed as means and standard errors of the means of two observations in each of the three dogs, so that n = 6 for each value. The means of two gastrin values were obtained for each dog at each time interval for each of the three series of studies and are shown in Table 1. Means and standard errors of the means were calculated for n = 3. Significance was assessed with the Student t test for unpaired values. Differences were considered significant if P < 0.05.

Table 1. Serum gastrin before, 30, and 60 min after a meal

<table>
<thead>
<tr>
<th>Dog</th>
<th>Before Parenteral Feeding</th>
<th>After Parenteral Feeding for 1 mo</th>
<th>Normal Oral Diet for 1 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basal 30 min 60 min</td>
<td>Basal 30 min 60 min</td>
<td>Basal 30 min 60 min</td>
</tr>
<tr>
<td>A</td>
<td>101 228 410</td>
<td>46 126 169</td>
<td>55 194 254</td>
</tr>
<tr>
<td>B</td>
<td>122 320 357</td>
<td>59 207 287</td>
<td>151 430 630</td>
</tr>
<tr>
<td>C</td>
<td>103 189 193</td>
<td>71 223 180</td>
<td>199 406 577</td>
</tr>
<tr>
<td>X</td>
<td>109 243 396</td>
<td>29 180 292</td>
<td>135 344 487</td>
</tr>
<tr>
<td>SEM</td>
<td>7.7 41 23</td>
<td>7.2 30 33</td>
<td>42 75 118</td>
</tr>
</tbody>
</table>

Values are in picograms per milliliter. Experiments were done before, 1 mo after the start of total parenteral feeding, and 1 mo following return to normal oral food intake. * P < 0.001. † P < 0.005. ‡ P < 0.05. § P < 0.01.
FIG. 1. Acid secretion from vagally denervated Heidenhain pouch following a meal. Before, before intravenous alimentation. During, at end of a 30-day period of total parenteral feeding. After, 1 mo after dogs had resumed normal food intake. Means and standard errors of means of two observations in each of three dogs.

FIG. 2. Same as Fig. 1, except pepsin output was measured.

higher than control levels after the dogs had been feeding normally for 1 mo (Table 1)

DISCUSSION

This is the first study to examine the effects of the long-term absence of food from the gut on gastric secretion. There have been several studies from the surgical literature concerning the mechanism by which total

FIG. 3. Acid secretion in response to different doses of pentagastrin. Otherwise, same as Fig. 2.

FIG. 4. Same as Fig. 3, except pepsin output was measured.

FIG. 5. Same as Fig. 3, except secretion was collected from vagally innervated main stomach via gastric fistula.
oral water intake was given intravenously. The animals
nervated canine pouches during periods when normal
osmotic diuresis occurred in all experiments.
changes in plasma osmolarity could explain findings.
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lase had no effect.
infusion of 20% dextrose alone caused at 30% inhibition of vol-
Ringer solution and then for 50 min in a test "hyperali-
mentation" solution. During the infusion of the first
solution, 20% dextrose plus 5% amino acids, volume
decreased 50%, bilirubin decreased 86%, and amylase
and protein output each decreased about 70%. Infusion
of 20% dextrose alone caused at 30% inhibition of vol-
ume, and 80, 40, and 85% decreases of bilirubin, amy-
lase, and protein outputs, respectively. Amino acids
alone caused lesser decreases in outputs. The authors
concluded that dextrose was directly responsible for the
suppression of secretion, although amino acids present
in intravenous diets could also inhibit protein and bili-
rubin output.
The conclusions from both these studies could possibly
be in error. First, the studies were not controlled for
time—the dextrose and amino acid solutions were al-
ways given during the last hour of the study. Second,
changes in plasma osmolarity could explain findings.
Osmotic diuresis occurred in all experiments.
Wilmore et al. (14) examined acid secretion from
denervated canine pouches during periods when normal
oral water intake was given intravenously. The animals
ate normal diets but fluid intake was entirely by vein as
either 5% dextrose in water or 5% dextrose in saline in
volumes equal to or twice the normal oral intake for
each dog. Heidenhain pouch secretion decreased 22%
when dextrose was administered in water and increased
33% when administered with saline. Doubling the vol-
ume had no effect.
The studies outlined above assume that changes in
secretion during periods of parenteral feeding are due to
acute effects of the nutrient solution on the secretory
processes. Although changes were observed, the designs
of the studies were such that possible mechanisms be-
hind the changes were not revealed. The current study
operates from a completely different premise, namely,
that secretory changes might occur from the chronic
absence of stimulation normally provided by the oral
ingestion and presence of food within the digestive
tract.
Experiments involving parenteral alimentation in
rats support this contention. The weights of the oxyntic
gland area of the stomach, the small intestine, and
pancreas from rats fed intravenously for 10 days were
significantly lower than corresponding values from
sham-operated orally fed controls (8). The body weights
and weights of other organs did not change. Antral
and serum gastrin levels were also significantly lower in the
parenterally fed rats (8, 9). The addition of a low dose of
pentagastrin to the intravenous nutrient solution pre-
vented most gastrointestinal tract weight loss as well as
the decreases in disaccharidase activity which occur in
these animals (2, 9). On the basis of the rat data one
might have expected canine gastric secretion in re-
ponse to pentagastrin to be decreased because of de-
creased mass of secretory mucosa and the response to a
meal to be decreased for the same reason and because of
lower endogenous gastrin levels. This clearly was not
the case for the vagally innervated stomach.
Even though basal serum gastrin levels decreased
50% as a result of parenteral feeding, the serum gastrin
response to the meal was unchanged at 30 min and only
slightly lower than control levels 60 min after feeding.
In fact, the percentage change in serum gastrin level in
response to a meal was greater following the period of
intravenous feeding than it was during the control pe-
riod 1 mo earlier. The fact that both acid and pepsin
outputs from the main stomach were unchanged during
the course of the experiment indicates that neither the
parietal cell mass nor the sensitivity of the parietal cells
to gastrin changed during the prolonged absence of food
from the stomach.
Acid and pepsin output from the vagally denervated
Heidenhain pouch, however, decreased significantly in
response to both pentagastrin and food. The calculated
maximal output of the Heidenhain pouch in response to
pentagastrin decreased from the control value of 1.163
meq H+ /30 min to 0.683 meq H+ /30 min after 1 mo of
intravenous feeding. During the same period the Km
or D50 for acid secretin increased from 1.37 to 2.62. These
changes imply that both the secretory mass (or individ-
ual parietal cell response) and parietal cell sensitivity to
pentagastrin decreased during this period of time. This
![Graph showing the effect of pentagastrin on pepsin secretion over time.](http://ajpendo.physiology.org/)
accounts for the large decrease in acid secretion. That these changes were not permanent is evidenced by the total recovery of secretory capacity after the animals resumed normal oral feeding. The pouch response to food was depressed even more than the response to pentagastrin. The factors, mentioned above, responsible for the decrease to pentagastrin stimulation are, in part, responsible for the decreased secretion in response to a meal. To these must be added the significantly decreased serum gastrin response which was evident 60 min after eating.

This is the first study examining the effects of long-term absence of an oral food intake on the dog stomach. Numerous species differences are evident when compared to the rat. After 10 days of parenteral nutrition, rat serum gastrin decreased to one-eighth control levels (9) compared to one-half in the current study. Food deprivation for a period of 4 days in the rat resulted in a drop in serum gastrin levels to one-seventh the normal level (1). Thus, maintenance of rat gastrin levels seems to decrease serum gastrin response which was evident 60 min after eating.

The fact remains that the vagally innervated main stomach was immune to the factor which decreased the sensitivity and secretory mass of the Heidenhain pouch parietal cells. The only explanation for this phenomenon is the obvious one, that in some way vagal innervation maintained the sensitivity of the oxyntic gland mucosa to various secretory stimuli and, at the same time, compensated for slightly decreased serum gastrin levels.

Assuming that the human stomach more closely resembles the canine mucosa, the absence of food for periods of time during intravenous feeding is not likely to cause atrophy of the innermost gastric mucosa or other trophic factors canceled the effects of changes in gastrin levels. Although the secretory capacity of the Heidenhain pouch decreased, the reason for this is not apparent. There is no evidence on the question of whether gastrin is a more potent growth hormone in vagally denervated mucosa. The in vivo experiments demonstrating trophic effects of gastrin, to our knowledge, have all been performed with innervated tissues (7).

REFERENCES


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