

The Relationship of Gastroesophageal Reflux and Gastric Emptying in Infants and Children: Concise Communication

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One hundred twenty-six pediatric patients (0–16 yr of age) with clinically suspected gastroesophageal reflux (GER) were evaluated using radionuclide scintigraphy. Although 46 of the patients (38.3%) had abnormal studies exhibiting evidence of GER, there were no significant differences in gastric emptying between patients with and without GER. At 60 min after ingestion, the 76 patients less than 2 yr old had a mean residual of 54%, whereas those over 2 yr of age had a value of 29% ($p < 0.0001$). Gastric emptying values may be age-related.

J Nucl Med 25: 571–574, 1984

Interest in gastric emptying in children with gastroesophageal reflux (GER) has been stimulated by the reported association of delayed gastric emptying and gastroesophageal reflux (1). It has been suggested that the delay in gastric emptying may be responsible for some cases of gastroesophageal reflux where treatment with metoclopramide or bethanecol would be appropriate. We have analyzed the gastric emptying data of 126 infants and children studied with radionuclides for gastroesophageal reflux. The purpose was to determine whether a relationship exists between gastric emptying and gastroesophageal reflux.

SUBJECT AND METHODS

The study population consisted of 126 consecutive patients referred for gastroesophageal scintigraphy. Referral was prompted by symptoms such as emesis, regurgitation, recurrent pneumonitis, apnea, a sibling with sudden infant death, and (in older subjects) recurrent abdominal pain.

Following a 4-hr fast, patients received a feeding of 5% dextrose and water containing a maximum of 1 mCi of Tc-99m sulfur colloid. The volume of fluid ingested

was adjusted to the patient's age. Immediately following the ingestion, the patient lay in the supine position and a gamma camera equipped with a high-sensitivity, parallel-hole collimator was positioned posteriorly. Images were recorded in a 64×64 digital matrix in 30-sec frames for 60 min. Simultaneously, analog images were obtained on transparency film at one image every 2 min.

Data were processed for the detection of gastroesophageal reflux as described by Heyman et al (2). The 120 frames obtained during the first hour were summed and displayed with an upper threshold of 5–10% of the peak activity in order to demonstrate abnormal areas of activity in the esophagus or lungs. Time-activity curves for regions of interest drawn over the esophagus were obtained. The detection of activity in the esophagus at any time during the study—whether by the summed images, sequential analog images, or time-activity curves—was considered abnormal and indicative of gastroesophageal reflux. Following correction for decay of Tc-99m, gastric emptying was quantitatively expressed as the percentage remaining at 60 min. An area of interest was selected over the stomach for the first and last 30-sec frames. Following background subtraction, the percent gastric residual at 60 min was calculated:

$$\% \text{ Gastric residual} = \frac{\text{gastric counts at 60 min} \times 100}{\text{gastric counts at 0 min}}$$

Received Sept. 30, 1983; revision accepted Jan. 31, 1984.

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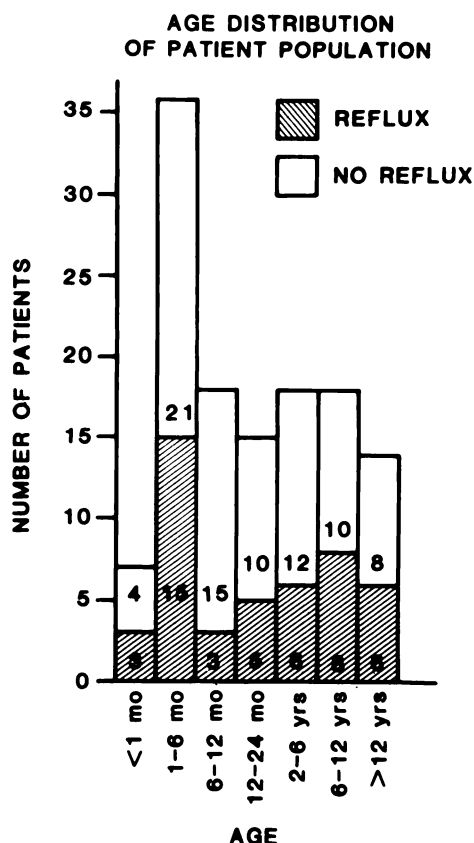


FIG. 1. Histogram showing age distribution and occurrence of gastroesophageal reflux in population studied.

RESULTS

Forty-six of the 126 patients (38.3%) had abnormal gastroesophageal scintigrams and were considered to have gastroesophageal reflux. The age distribution of the patient population is shown in Fig. 1. Figure 2 depicts the relationship between gastroesophageal reflux and

gastric emptying values. Patients with gastroesophageal reflux had the same mean age as those with normal studies, and exhibited no significant difference in their gastric emptying values (Table 1).

Seventy-six patients were less than 24 mo of age, and 37% of these (26 patients) had abnormal gastroesophageal scintigrams. There was no difference in the mean values for gastric emptying or the mean age of the infants between normal and abnormal scintigraphic studies (Table 2). Fifty patients were between 2 and 16 yr of age. The 20 patients with abnormal gastroesophageal scintigrams in this age grouping also exhibited no significant difference in mean age or mean gastric emptying when compared with those having normal studies (Table 2).

When patients are grouped by age only, however, regardless of the results of the gastroesophageal scintigram, there is a significant difference in the mean gastric emptying value ($p < 0.0001$) when those less than 2 yr old are compared with those above that age.

DISCUSSION

The acquisition of gastric emptying data by radio-nuclide scintigraphy has become an integral component of the routine study of the pediatric patient for gastroesophageal reflux. The diagnostic and therapeutic rationale for the analysis of such data resides in the reported association of delayed gastric emptying in infants with gastroesophageal reflux, as well as the availability of agents such as bethanechol and metoclopramide for the pharmacological treatment of disorders of gastrointestinal motility (1).

The diagnostic accuracy of gastroesophageal scintigraphy in the evaluation of infants for reflux is still uncertain. Blumhagen et al. considered a gastroesophageal scintigram to be clinically insignificant ("nega-

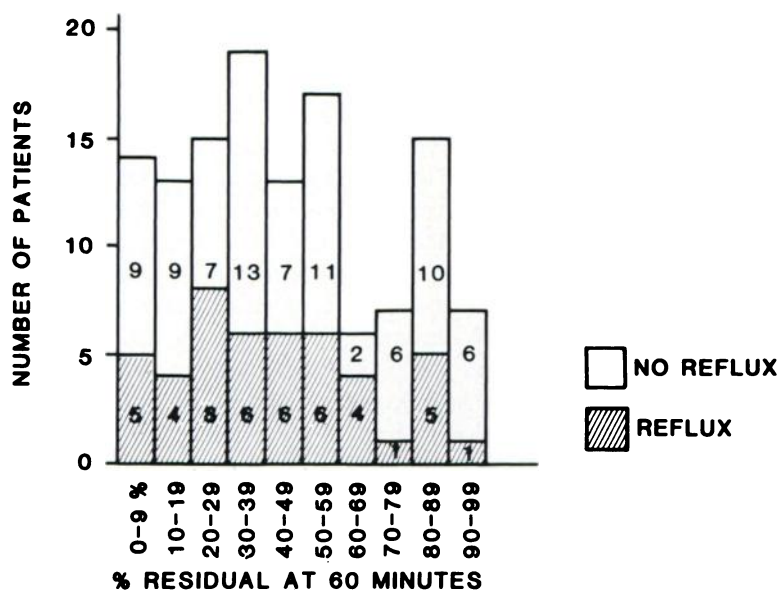


FIG. 2. Histogram of gastric emptying values and relationship to gastroesophageal reflux.

TABLE 1. GASTRIC EMPTYING COMPARED WITH GASTROESOPHAGEAL REFLUX

Gastroesophageal reflux	No. of subjects	Mean age (mo)	% Residual \pm s.d.
Yes	46	51	42 \pm 25
No	80	44	46 \pm 28

tive") if there were two or less episodes noted in the first 5 min of observation (3). Thirteen of their 65 patients had studies with such findings. Seven of these 13 had positive acid reflux tests. The sensitivity of radionuclide studies was 75% for the population studied, and specificity was not evaluated. Both Seibert et al. (4) and Arasu et al. (5) evaluated the diagnostic accuracy of scintigraphy, using the 24-hr pH probe and acid reflux tests as the "gold standard." The criterion for a positive radionuclide study was the demonstration of radionuclide in the esophagus at any time during the 60-min period of observation. This agrees with the criterion used in this study and by Heyman (2). Using this criterion, Arasu reported no false-positive studies in 13 controls. In 29 patients with positive acid reflux tests, 16 had positive scintigrams (55%) (5). Seibert, using the 24-hr pH probe study as the definitive test, also found that reflux at any time during the 1-hr monitoring with scintigraphy was significant. Using this criterion for scintigraphy, the sensitivity was 79%, with a specificity of 93% (4).

Our studies of gastric emptying did not demonstrate significant differences between infants and children with and without gastroesophageal reflux. Of the 29 patients exhibiting a mean percent residual in excess of 70%, only 7/29 (24%) had gastroesophageal reflux demonstrated by radionuclide study (Fig. 2).

Seibert et al. studied gastric emptying and GER in 49 infants (4,6). Fifteen of the 49 had GER, but there was no firm association of reflux with delayed emptying. However, of the five patients that Seibert identified with delayed gastric emptying, four had a positive 24-hr pH probe tests. These patients had negative 1-hr pH probe and gastroesophageal scintigrams, suggesting that abnormal gastric emptying may cause reflux later than 1 hr after tracer ingestion (6).

Like Seibert, our results disagree with the work of Hillemeier et al., where 23 children with GER were evaluated (1). Thirteen with serious sequelae of GER exhibited more reflux and slower gastric emptying than normal adult controls or patients with less severe reflux.

While there is wide variability in gastric emptying throughout all age groups, there is a general tendency toward greater emptying in the older ages (Table 2). If those aged 2 yr or less are compared with those older

TABLE 2. AGE-RELATED ANALYSIS GASTRIC EMPTYING COMPARED WITH GASTROESOPHAGEAL REFLUX

Gastroesophageal reflux	No. of subjects	Mean age (mo)	% Residual \pm s.d.
<u>0-0-2 yr</u>			
Yes	26	7	53 \pm 25
No	50	8	55 \pm 29
<u>2-16 yr</u>			
Yes	20	108	28 \pm 18
No	30	105	31 \pm 19

than 2 yr, there is a significant difference (54% compared with 30%, $p < 0.0001$). We are unable, however, to establish definitive normal values for gastric emptying functions of either infants or children, due to the lack of bonafide normal controls. (We feel it is not justifiable to subject normal infants who exhibit no symptoms of reflux or abnormalities of gastrointestinal motility to radionuclide gastric emptying studies—this despite the low radiation dose.)

Our values, using 5% dextrose and water, are in close agreement with those of Seibert et al., who administered a milk formula (6). They expressed their results as percent emptying in 1 hr, with their infants having a (48 ± 16 s.d.) % emptying (i.e., 52% residual). In a comparable group, our data revealed a value of (46 ± 27) % if converted to the Seibert percent emptying.

In conclusion, we report what appears to be an association between age and rate of gastric emptying as expressed by mean percent residual at 1 hr after ingestion. Furthermore, we find no association between the presence or absence of gastroesophageal reflux and the rate of gastric emptying.

ACKNOWLEDGMENTS

This work was presented at the 30th Annual Meeting of the Society of Nuclear Medicine, St. Louis, Missouri, June 1983. We thank Rosanne O'Toole for secretarial services and support.

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