Does simultaneous gastric and esophageal pH monitoring increase the diagnosis of gastroesophageal reflux disease?

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The duration of gastric acidity may affect the interpretation of esophageal pH monitoring study. The aim of this study was to increase the sensitivity of pH monitoring by simultaneous gastric and esophageal pH recording. Fifty-seven patients were enrolled in the study. After the first analysis, the recording periods in which gastric pH was >4 were excluded and after this exclusion parameters were recalculated. Of the 57 patients, 14 (24.6%) (mean age, 70±4.6 years) were diagnosed as having gastroesophageal reflux disease with the use of conventional method. After correction, gastroesophageal reflux disease diagnosis was made in 6 additional patients (mean age, 2.4±2.4 years) and total number of patients with reflux increased to 20 (35.1%) (p=0.031). The mean percentage time of gastric pH>4 was significantly greater in children younger than 2 years of age than that in those older than 2 years of age (50.6%±15.2% vs 33.7%±18.1%) (p=0.001). Exclusion of periods in which gastric pH>4 affected the results more obviously in patients younger than 2 years. Simultaneous gastric and esophageal pH monitoring is useful for the diagnosis of gastroesophageal reflux disease, particularly in children younger than 2 years of age.

Key words: gastroesophageal reflux disease, simultaneous gastric and esophageal pH monitoring.

Gastroesophageal reflux (GER) is a common problem in childhood and is defined as the spontaneous passage of gastric contents into the esophagus. GER is a physiological event in healthy children and becomes pathological when its complications like failure to thrive, esophagitis, and persistent respiratory symptoms occur (termed gastroesophageal reflux disease [GERD])[1]. Therefore, early diagnosis is important to prevent these complications. Twenty-four hour esophageal pH monitoring is considered to be the first choice investigation technique in diagnosis of GERD. The classic pH monitoring parameters are the reflux index (RI: percentage of total time that esophageal pH is below 4), the number of reflux episodes, the number of reflux episodes longer than five minutes, and duration of the longest episode of reflux. Only acid reflux (esophageal pH below 4) can be detected using these parameters[2]. However, in children, the gastric acidity period is limited due to frequent feeding with neutralizing foods[3]. This may prevent detection of reflux events, especially in the first two postprandial hours, and may cause false negative results by lowering RI. Simultaneous gastric and esophageal pH monitoring enables the identification and exclusion of the periods in which gastric pH is >4[4,5]. The aim of this study was to determine whether the sensitivity of pH monitoring may be increased by excluding these periods.

Material and Methods

During a 12-month period, 57 patients who were suspected of having GERD were enrolled in this study. Ethical approval for the study was obtained from the Research Ethics Committee of Hacettepe University, Faculty of Medicine. The procedure was explained to the patients and/or parents and informed consent was obtained. Any anti-reflux medication was stopped four days before pH monitoring. For simultaneous gastric and esophageal pH monitoring, disposable antimony catheters (Medtronic Synectics,

Stockholm, Sweden) with two sensors at a distance of 5 or 10 cm, depending on the age of the patient, were used. Before and after monitoring the catheters were calibrated in buffers at pH 7.01 and pH 1.07. The catheter was introduced transnasally and the proximal sensor was placed to a distance calculated by Strobel's formula [0.87x(0.252xbody length+5 cm][6]. The distal sensor was placed in the gastric body and exact placement of the sensors was controlled with a chest radiograph. The pH changes were recorded every four seconds by a Digitrapper Mark III (Synectics Medical AB, Stockholm, Sweden) device. Feeding and nursing times, and clinical signs and symptoms were recorded in an event diary by either parents or the patients. At the end of the recording, the data were transferred to a personal computer and analyzed with EsopHagram software (Gastrosoft, Irving, Texas, USA). All records were reviewed by one of the investigators (HD) to identify artifact that was excluded from analysis, and RI was then calculated. After the first analysis, the recording periods in which gastric pH was >4 were excluded to the extent possible and RI was then recalculated and expressed as "corrected reflux index (CRI)".

For each calculation, a diagnosis of GERD was made if RI was greater than 4%[7]. Differences between means were tested with Mann-Whitney U test or Wilcoxon signed rank test when appropriate. Difference in the proportions were tested with chi-square or McNemar tests when appropriate. Values are expressed as mean±SD and a p value less than 0.05 was considered as significant.

Results

Of the patients, 36 (68%) were male and 21 (37%) were female. Their ages ranged from 3 months to 14 years (mean, 4.3±3.9 years; median, 2.5 years) and 23 (40%) were younger than two years. The most frequent symptom was vomiting (68.4%) followed by cough (40.4%), wheezing (24.6%) and abdominal pain (15.8%).

The ratio of gastric pH>4 was between 0.9% and 87.2% of the total recording time (mean±SD, 40.5%±18.8%). After excluding the periods in which gastric pH was >4, the mean ratio of gastric pH>4 decreased to 13.2%±10.6% (range 0.3%-60.9%) (p<0.001). The mean RI was 4.6%±7.9% (range 0-50.8%). After correction, the CRI (percentage of time that the esophageal pH was >4 after ignoring the periods in which gastric pH was >4) increased to 5.5%±8.6% (range 0-54%) (p<0.001).

Of the 57 patients, 14 (24.6%) (mean age, 7.0±4.6 years) were diagnosed as having GERD with the use of standard parameters. After correction, GERD diagnosis was made in six additional patients (mean age, 2.4±2.4 years) and the total number of patients with reflux increased to 20 (35.1%) (p=0.031). The mean age of six patients diagnosed after recalculation was significantly lower than that of the 14 patients initially diagnosed (p=0.03). The mean percentage of time that gastric pH was <4 was significantly lower in these six patients than in the other 14 (54.0%±14.0% vs. 71.7%±16.0%, p=0.03).

When the patients were divided into two groups according to their ages, the mean percentage time of gastric pH>4 was significantly greater in children younger than two years of age than in those older than in those older than two years of age (50.6%±15.2% vs 33.7%±18.1%) (p=0.001) (Table I). Exclusion of periods in which gastric pH was >4 affected the results more obviously in patients younger than two years. Before correction, reflux was detected in 3 of 23 (13%) children younger than two years and in 11 of 34 (32%) children older than two years. After correction, four patients younger than two years of age and two older than two years of age were diagnosed as GERD, and the ratios of patients with GERD increased to 30% (7/23) and 38% (13/34), respectively (p=0.12 and 0.5, respectively).

Table I. pH Monitoring Results in Children Younger and Older than Two Years of Age

Characteristics	Age of the patients		
	>2 years (n=34)	<2 years (n=23)	P
Gastric pH>4 (%)* (mean±SD)	33.7±18.1	50.6±15.2	0.001
Gastric pH>4 (%)** (mean±SD)	14.1±8.0	12.7±12.2	NS
GERD (n)#	11	3	NS
GERD (n)†	13	7	NS

* Values calculated by conventional method (% of total recording time).
** Values calculated after excluding the periods in which gastric pH was >4 (% of total recording time).
# By conventional method.
† After excluding the periods in which gastric pH was 4.
GERD: gastroesophageal reflux disease.

Discussion

Detection of esophageal acidity by 24-hour pH monitoring is the gold standard method for the diagnosis of GERD. Esophageal acidity is caused

mainly by the reflux of gastric contents, and gastric acidity is the major determinant of esophageal acid exposure. Volume and content of meal, gastric emptying rate and gastric acid secretion influence gastric acidity. Gastric acidity time is usually short in young children as a result of neutralization of gastric contents[3-5]. Milk has a good buffering effect and neutralizes gastric pH for a long period. Mitchell et al.[4] reported then average time that the gastric pH was >4 after milk feeds was a mean of 130 minutes. The effect of formula feeding on gastric acidity was also evaluated[8]. The mean duration of gastric pH>4 was found to be 44% of the postcibal period in infants fed with formula. However, the feeding pattern of older children resembles that of adults. Gastric. pH becomes acidic for longer periods as a result of decreased feeding frequency. In an adult study, Ducrotte et al.[9] showed that gastric pH was <4 for a mean of 89% of the recording time. Similar to those reports, we found shorter gastric acidity time in children aged less than two years than in older children.

We simultaneously monitored gastric and esophageal pH in our patients. The ratio of gastric pH>4 ranged from as low as 0.9% to as high as 87.2%. After excluding the periods in which gastric pH was 4 to the extent possible, the ratio of gastric pH>4 decreased significantly ($p<0.001$), and six additional patients were diagnosed as GERD versus the 14 patients diagnosed using conventional parameters ($p=0.031$).

The most striking finding was that the mean age of newly diagnosed patients was significantly lower than that of the patients diagnosed at the first calculation. Additionally, the mean period of gastric pH<4 was lower in these patients and the exclusion of gastric pH>4 affected these patients more significantly. The ratio of patients who had reflux after correction was higher in children younger than two years old than in the older ones, although it did not reach a statistically significant level. Thus may have been due to the small number of the patients (type II error).

In conclusion, simultaneous gastric and esophageal pH monitoring is useful for the diagnosis of GERD, particularly in children younger than two years of age. In this age group, gastric pH tends to be higher due to frequent intake of neutralizing foods such as milk or formula. Instead of giving patients acidified foods, which is not physiological, it may be better to identify and exclude the periods in which gastric pH is >4 by using simultaneous gastric and esophageal pH monitoring.

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