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SELF-STUDY TEST

Gastrointestinal Nuclear Medicine

Questions are taken from the *Nuclear Medicine Self-Study Program I,* published by The Society of Nuclear Medicine

DIRECTIONS

The following items consist of a heading followed by numbered options related to that heading. Select those options you think are true and those that you think are false. Answers may be found on page 1807.

A 43-yr-old man has paroxysmal coughing, which frequently leads to vomiting. Single-swallow (Fig. 1) and multiple-swallow (Fig. 2) esophageal transit studies and a reflux study (Fig. 3, see p. 1807) are shown. An upper gastrointestinal series showed a small hiatal hernia. Which of the following conditions are documented by these studies?

1. gastroesophageal reflux
2. distal esophagitis with stricture
3. esophageal dysmotility secondary to esophagitis
4. pulmonary aspiration

Gastroesophageal scintigraphy, when employed to evaluate children, has proved to be a reliable test for demonstrating

5. gastroesophageal reflux.
6. esophageal motility abnormalities.
7. pulmonary aspiration.
8. gastric emptying abnormalities.

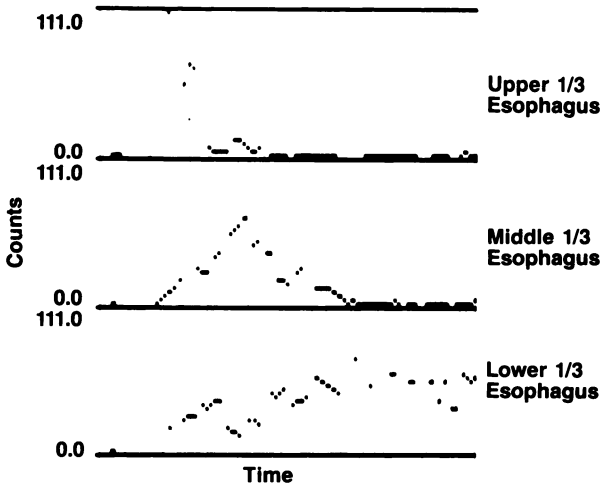

Figure 1

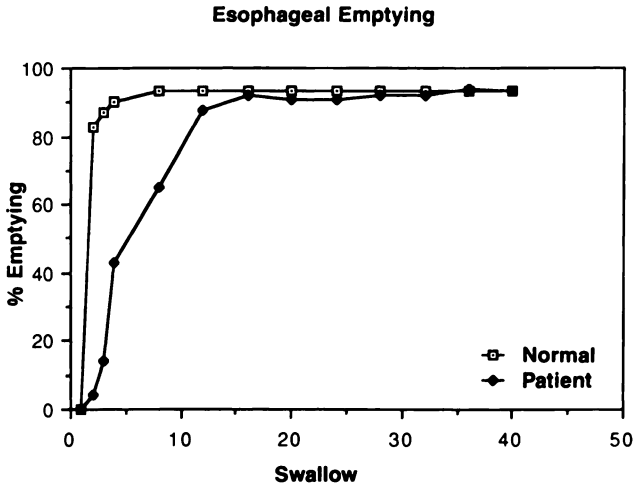

Figure 2

True statements regarding Meckel's diverticulum in children include which of the following?

9. It is the most frequent cause of severe lower gastrointestinal bleeding in infants and small children who otherwise appear well.
10. It contains ectopic gastric mucosa in less than 20% of patients.
11. Before [^{99m}Tc]pertechnetate imaging, potassium perchlorate should be given to decrease radiation exposure to the thyroid gland.
12. Technetium-99m-pertechnetate imaging should detect between 80% and 90% of symptomatic Meckel's diverticula.
13. A negative [^{99m}Tc]pertechnetate study excludes the presence of a Meckel's diverticulum in about 90% of symptomatic patients.

(continued on page 1807)

heart disease using radionuclide determined regional ejection fraction at rest and during handgrip exercise: correlation with coronary arteriography. *Circulation* 1978;58:640–648.
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(continued from page 1787)

SELF-STUDY TEST

True statements concerning bacterial overgrowth and the ^{14}C-xylose breath test include which of the following?

14. Normal host tissue metabolism can result in high levels of CO_2 gas production.

15. Xylose is catabolized only by Gram-negative anaerobic bacteria.

16. Administration of 1 g of xylose normally increases endogenous CO_2 output by about 30% over basal levels.

17. Xylose is absorbed primarily in the small bowel.

18. A negative culture from a small bowel biopsy excludes bacterial overgrowth.

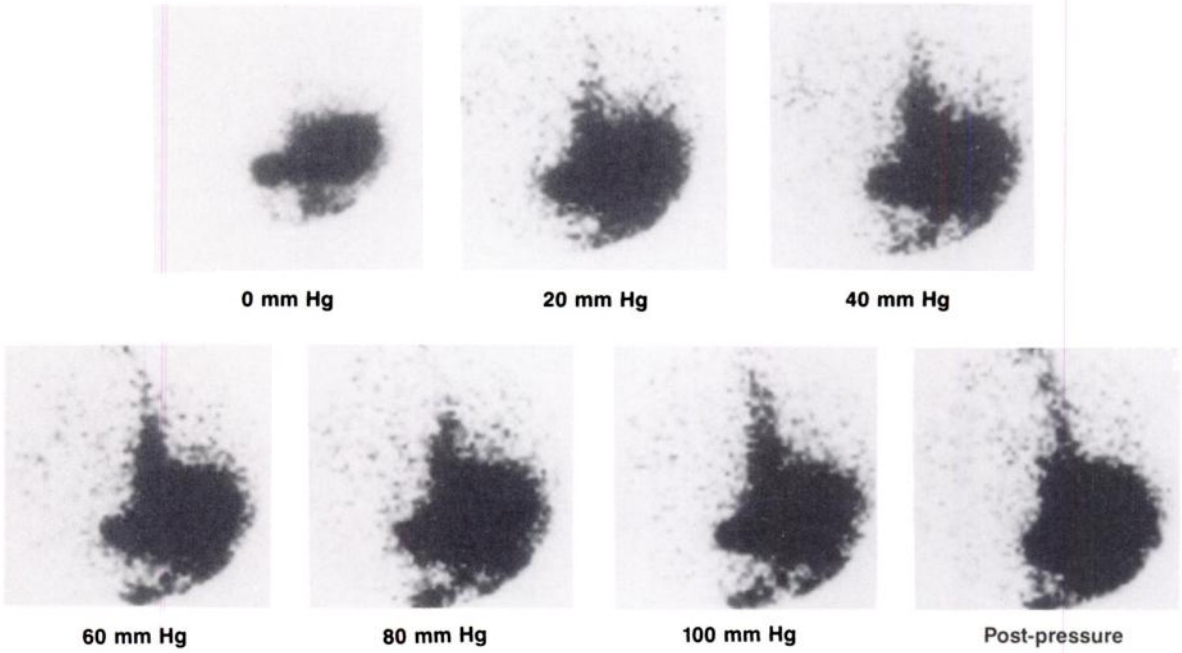

Figure 3

SELF-STUDY TEST
Gastrointestinal Nuclear Medicine

ANSWERS

ITEMS 1–4: Gastroesophageal Transit and Reflux

ANSWERS: 1, T; 2, F; 3, T; 4, F

Gastroesophageal reflux is clearly present (Fig. 3), and both the transit curves and "global" clearance curve indicate the presence of a mild motility disorder, which is characteristic of reflux esophagitis.

Although there is some apparent dilatation in the region of the distal esophagus, this can be explained by the anatomic finding of a hiatal hernia. A diagnosis of esophagitis with stricture should not be made on the basis of gastroesophageal scintigraphy and should be made either from a barium swallow or at the time of endoscopy. The transit curves derived from the upper, middle, and lower thirds of the esophagus (Fig. 1) show retention in the distal esophagus. However, there is also a diffuse esophageal motility disorder, evidenced by the delay in transit of the bolus peak throughout the entire esophagus. Examination of the multiple-swallow emptying curve for the esophagus (Fig. 2) shows a pattern typical of esophagitis, with initially delayed clearance but eventual emptying of the esophagus after approximately 15 swallows. In a stric-

(continued on page 1812)

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(continued from page 1807)

SELF-STUDY TEST
Gastrointestinal Nuclear Medicine
ANSWERS

ture one would not expect such rapid clearance. Using the multiple swallow emptying curves, Tolin et al. were able to show differences in the degree of retention in patients with esophagitis, including both those with normal motility and those with a motor disorder. In both circumstances clearance was only mildly impaired compared with that in patients with achalasia, diffuse esophageal spasm, and scleroderma. On endoscopy this patient was found to have distal esophagitis and antral gastritis.

Although there is no documentation of wheezing along with the patient's cough, the history nonetheless raises the question of pulmonary aspiration. Pulmonary aspiration cannot be confirmed with the available images, however. One would need to obtain frequent images of the lungs with enhancement of the gray scale (by digital display) to bring out subtle focal areas of abnormal activity in the lungs. Because of the difficulties reported in visualization of pulmonary aspiration, this diagnosis cannot be excluded with a negative study but can be confirmed if positive.

Reference

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ITEMS 5–8: Gastroesophageal Scintigraphy in Children

ANSWERS: 5, T; 6, T; 7, F; 8, T

Quantification of esophageal scintigraphy is routinely performed in adults, but quantitative scintigraphy of esophageal motility in children has not been evaluated extensively. Qualitative information obtained from an evaluation of the recording of multiple swallows has been useful in infants and small children. Normally, there is a smooth progression of swallows down the esophagus with early gastric filling. Motility disorders associated with various pathologic states, such as esophageal atresia after surgical repair, achalasia of the esophagus, scleroderma, and esophagitis may be demonstrated. Older children who can cooperate can be studied by single-bolus methods, and studies can be quantified in the same fashion as in adults.

Scintigraphy is ideally suited for detecting gastroesophageal reflux, particularly because reflux occurs intermittently in most patients and monitoring can be extended over a prolonged period of time. Barium studies provide better resolution but suffer from the disadvantage that imaging is intermittent over a short period of time. The 24-hr pH probe study generally is regarded as the "gold standard." Though it is often difficult to compare studies between different centers due to lack of uniformity, it appears that scintigraphy has a sensitivity > 75%, and is generally more sensitive than the barium study (48%–80%) for detecting reflux. Manometry has proved to be a less sensitive indicator of reflux (38%–77%). An added advantage of gastroesophageal scintigraphy is that it is easy to perform, noninvasive, and can be performed on outpatients.

Although scintigraphy is capable of detecting small volumes of gastric content aspirated into the lungs, most investigators have detected pulmonary aspiration in a surprisingly small fraction of patients with reflux. This is most likely due to noncontinuous imaging of the lungs. Most imaging protocols have reported using anterior and posterior images obtained at the end of 1 hr, and have repeated these infrequently (usually at 2 and 18–24 hr). Ciliary action alone, in the absence of a cough reflex, has been shown to clear ^{99m}Tc-sulfur colloid from the upper airway with a $T_{½}$ of 1.7 hr in monkeys. With an intact cough reflex, clearance is much more rapid. Thus, with intermittent imaging, only the activity reaching the distal airway is likely to be detected, especially if there is a poor cough reflex. Despite the generally low frequency of detection of aspiration, Boonyaprapa et al. and Orellana et al. have reported higher detection rates (35%–55%) in patients with more severe pulmonary disease.

Gastric emptying of milk or formula mixed with ^{99m}Tc-sulfur colloid is easily quantified by monitoring gastric activity over at least 60 min (preferably 2 hr). Normal children have not been studied, but values in the literature suggest normal residual activity at 1 hr ranges from 36% to 70% after a milk feeding. A cow's milk formula isocaloric with human milk delays the emptying process, probably due to the different composition of the meals. It has been observed that, within limits, osmolar loads do not affect gastric emptying in infants and normal newborns. In older children, solid and liquid emptying of a standard meal may be determined with use of the same methods employed in adults.

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ITEMS 9–13: Meckel's Diverticulum in Children

ANSWERS: 9, T; 10, F; 11, F; 12, T; 13, T

The causes of lower gastrointestinal bleeding in children may be con-

(continued on page 1834)

annihilation radiation that arise whenever anti-matter equivalents capture each other. Positron-electron annihilation pairs are unique to that process, and the term positron in PET at least specifies the process that produced them.

In addition, ART is an acronym utterly familiar to any electrical engineer, signifying the algebraic reconstruction technique algorithm for image reconstruction from projection data. Thus, ART is doubly ambiguous. I think PET is a fine term and comes closer to meeting your own criteria than ART does. By the way, SPECT permits tomographic reconstruction in any orientation—not just the transaxial, as you imply. Try again Dr. Strauss!

REFERENCE

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REPLY:

EDITOR'S NOTE: *A rose by any other name . . . .*

(continued from page 1812)

SELF-STUDY TEST
Gastrointestinal Nuclear Medicine
ANSWERS

veniently classified according to age groups. Despite the fact that 50% of symptomatic patients with Meckel's diverticula present before the age of 2 yr, it is the most frequent cause of severe lower intestinal bleeding in all pediatric age groups.

Although Meckel's diverticula usually contain ileal mucosa, ectopic tissue including gastric, duodenal or colonic mucosa, and pancreatic tissue also may be present. The prevalence of gastric mucosa is estimated to be between 30% and 50%. Because hemorrhage results from mucosal ulceration in the diverticulum or adjacent ileum caused by the secretion of hydrochloric acid and pepsin, nearly all diverticula responsible for bleeding contain ectopic gastric mucosa.

The sensitivity with which ectopic gastric mucosa is detected depends, to a large extent, on the imaging technique. Patients should be studied after a 4-hr fast, to prevent the rapid emptying of [^{99m}Tc]pertechnetate from the stomach into the small bowel, which can obscure the field of interest. It is best to discontinue medications such as laxatives for 2–3 days, because these may cause hyperemia of the bowel with resultant increased accumulation of [^{99m}Tc]pertechnetate.

Although it is true that there is significant thyroidal uptake of [^{99m}Tc] pertechnetate, premedication with potassium perchlorate should not be performed. This not only will block thyroid uptake, but also will inhibit gastric uptake, in addition to that by salivary glands and choroidal plexus. It is useful to administer percholorate after completion of the study to facilitate washout of the tracer from the thyroid gland.

A review of 226 [^{99m}Tc]pertechnetate imaging studies with surgically proven diagnoses showed the sensitivity to be 85% and the specificity 95%. In another review there were 30 positive scans in 270 children. It was felt that the [^{99m}Tc]pertechnetate scan should detect 80%–90% of Meckel's diverticula, whereas a negative study excludes the diagnosis in over 90% of patients.

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ITEMS 14–18: Carbon-14-Xylose Breath Testing

ANSWERS: 14, F; 15, F; 16, F; 17, T; 18, F

King and Toskes have reviewed the ideal characteristics of a breath test for the diagnosis of bacterial overgrowth. Several factors favor the use of ^{14}C-xylose. It is primarily absorbed in the small bowel; thus, little normally reaches the colonic bacteria. There is no normal host tissue metabolism of xylose and no increase in endogenous CO_2 output will occur after administration of 1 g of xylose. In contrast, endogenous CO_2 output may increase with the bile-salt breath test. Sensitivity is greater with the xylose test because it is catabolized by Gram-negative aerobes, whereas the bile acid breath test depends on the presence of anaerobes, which may or may not be present in the overgrown flora.

King and Toskes report that many patients with malabsorption from bacterial overgrowth will have a positive xylose breath test and negative intestinal culture. These patients will show reversal of malabsorption following antibiotic therapy. Thus, the xylose breath test appears to be a more reliable functional indicator of bacterial overgrowth than the intestinal biopsy.

Reference

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Note: For further in-depth information, please refer to the syllabus pages included at the beginning of *Nuclear Medicine Self-Study Program I: Part I.*