Specificity of ^{99m}Tc-Pertechnetate in Scintigraphic Diagnosis of Meckel's Diverticulum: Review of 100 Cases

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Numerous reports in the recent literature have questioned the value of abdominal scanning with pertechnetate in the diagnosis of Meckel's diverticulum. In an attempt to evaluate further the specificity of pertechnetate in this condition, the clinical data and scintigrams of 100 patients with suspected Meckel's diverticulum were reviewed. The scintigram correctly identified Meckel's diverticulum before operation in seven of eight patients. One false-negative study occurred in 33 patients who underwent laparotomy. Conditions suggested as possible causes of false-positive studies (hydronephrosis, arteriovenous malformations, and intussusception) were found to give negative scans.

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Meckel's diverticulum occurs in 1.5–3% of the general population. The incidence of clinical symptoms secondary to this remnant of the omphalomesenteric duct ranges over 25–30% (*1,2*). Meckel's diverticulum is most commonly detected in the pediatric age group where the usual symptom is rectal bleeding with or without associated abdominal symptoms. The bleeding results from mucosal ulceration in the diverticulum or in the adjacent ileum caused by hydrochloric acid and pepsin secreted by the ectopic gastric mucosa (*1–5*). Ectopic gastric mucosa is present in nearly all diverticula of patients with symptoms of gastrointestinal bleeding (*1,3*).

Attempts to diagnose Meckel's diverticulum with barium contrast radiography and selective arteriography have been unsuccessful in most cases (*3,6–8*). However, the preoperative detection of Meckel's diverticulum has been facilitated recently by the introduction of ^{99m}Tc-pertechnetate abdominal scanning (*3–5,9–11*). Although this technique has been successful in numerous cases, several recent reports in the literature question its reliability (*6,11–15*).

During the 3 years from 1972 to 1975, 100 patients with clinically suspected Meckel's diverticulum were studied with pertechnetate scintigraphy of the abdomen. We reviewed the scintigrams and clinical data of these patients in an effort to determine the specificity of pertechnetate scintigraphy in detecting ectopic gastric mucosa, with special reference to possible causes of false-positive and false-negative results.

MATERIALS AND METHODS

Pertechnetate abdominal scintigrams were performed on 78 adults and 22 children (less than 15 years of age) with clinical symptoms suggestive of Meckel's diverticulum. The patients ranged in age from 2 months to 80 years. In addition, 11 patients with other conditions that have been suggested as possible causes of false-positive scintigrams for Meckel's diverticulum were evaluated; these included patients with hydronephrosis, intussusception, and arteriovenous malformations. The scintigrams were interpreted with no prior knowledge of the surgical or clinical diagnosis. All patients had undergone barium contrast examinations of the small bowel, colon, and upper gastrointestinal tract. In more than 90% of the patients, barium studies were performed before the scans in order to exclude disorders of the

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TABLE 1. SCINTIGRAPHIC AND PATHOLOGIC CORRELATION IN 33 PATIENTS WITH SUSPECTED MECKEL'S DIVERTICULUM

	Meckel's diverticulum	
Scan	Present	Absent
Positive	7	2*
Negative	1	24

* One patient had ectopic gastric mucosa in the ileum near the site of a previously resected Meckel's diverticulum.

gastrointestinal tract that are more common than Meckel's diverticulum. When possible, the pertechnetate scans were not performed until 2 days after the barium contrast studies, so that residual barium would not interfere with external detection of ^{99m}Tc. Arteriography was performed in ten cases.

The patient was instructed to void immediately before scanning to minimize the chance that the bladder might obscure an inferiorly located lesion. Adult patients were given 5 mCi of ^{99m}Tc-pertechnetate intravenously; children (between 2 and 15 years) were given 3 mCi; and infants 70 μCi/kg. No perchlorate or other blocking agent was used since perchlorate can block uptake in a Meckel's diverticulum as well, thereby causing a false-negative study (*16*). Since maximal activity in the diverticulum occurs early, the scans were obtained 15 min after injection. (If scanning is delayed longer than 45 min, tracer concentrations in the small bowel or in stomach secretions reaching the small bowel cause enough abdominal background to mask a lesion.) Scans were made with a Model-84 dual-probe 5-in. rectilinear scanner (Ohio-Nuclear, Solon, Ohio) at 300 cm/min, with a maximum count of 1,000/cm^2. The direction of scanning was cephalad in order to minimize the effect of increasing bladder size during the 20–30 min required for the scan.

In an attempt to determine the exact site at which technetium is concentrated in gastric mucosa, autoradiography was performed on gastric mucosa obtained from the stomachs of three dogs and five rats. The autoradiographs were prepared by the liquid emulsion technique. Tissue samples measuring less than 5 mm in any direction were placed in vials of methyl butane at surgical removal and immediately frozen in liquid nitrogen. Frozen sections, approximately 8 μm thick, were placed on albumin-coated microscope slides. Tissue fixation was achieved by brief exposure of the slide to flame. (Liquid fixatives were unsatisfactory because the high solubility of pertechnetate in water, alcohol, etc., would cause the radionuclide to be eluted from the tissue.) The slides were flooded with warm liquid photographic emulsion (NTB-2 Eastman Kodak) and placed in a dehydrating chamber at 4°C for 24 hr. Following development and fixation, the sections were stained with Harris' modification of hematoxylin–eosin stain.

RESULTS

Of the 100 patients, 33 underwent laparotomy and Meckel's diverticulum was found in eight. Gastric mucosa and ulceration of the diverticulum or adjacent ileum were noted in each patient. Meckel's diverticulum was correctly identified with pertech-

FIG. 1. Pertechnetate scintigram before operation in 38-year-old woman shows abnormal tracer accumulation above bladder in midline (arrow). At operation, Meckel's diverticulum was found in this location.

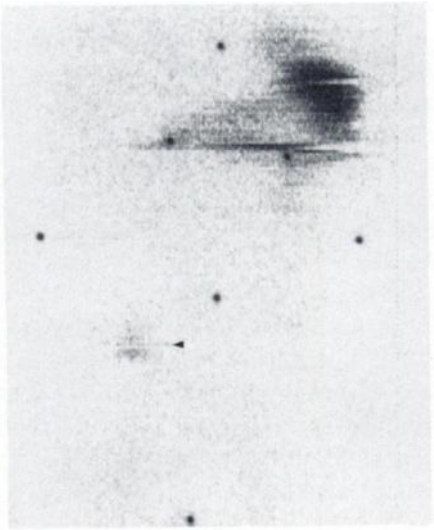

FIG. 2. Pertechnetate scintigram in 11-year-old girl shows tracer concentration in Meckel's diverticulum in right lower quadrant (arrow).

netate scans before operation in seven of these eight patients: five children and two adults (Table 1). Figures 1 and 2 show representative scan findings for Meckel's diverticulum.

In one additional patient the scan was interpreted as negative, but at laparotomy intussuscepted Meckel's diverticulum was found. The diverticulum measured 1.5 × 3 cm, and it contained little intact gastric tissue because of considerable scarring. This factor could explain the false-negative scintigram in this patient.

Scintigrams were interpreted as positive in one additional patient and equivocal in another. In the former, two discrete areas of uptake were identified in the left upper quadrant (Fig. 3). At laparotomy multiple ulcerations were found in the ileum in the left upper quadrant adjacent to the site of a previously resected Meckel's diverticulum. These ulcerations were located within islands of ectopic gastric mucosa. In the equivocal scan, the lower abdomen showed a larger area of uptake than one would expect with a diverticulum (Fig. 4). Because of several episodes of rectal bleeding, the patient underwent laparotomy, but neither a diverticulum nor any other explanation for the abnormal scintigram could be found. Thus, of nine patients with positive scintigrams (Table 1), ectopic gastric mucosa was identified in eight.

Several reports in the literature have discussed false-positive abdominal scintigrams. The suggested causes include intussusception, hydronephrosis, arteriovenous malformations, and peptic ulceration of the small intestine. To evaluate these conditions further, we scanned 11 additional patients: four with intussusception, four with arteriovenous malformations, two with hydronephrosis, and one patient with peptic ulceration of the small intestine. Scintigrams were negative in all patients except one who had ectopic islands of gastric mucosa in the ileum. Therefore, unless gastric tissue was present, the pertechnetate scans were negative.

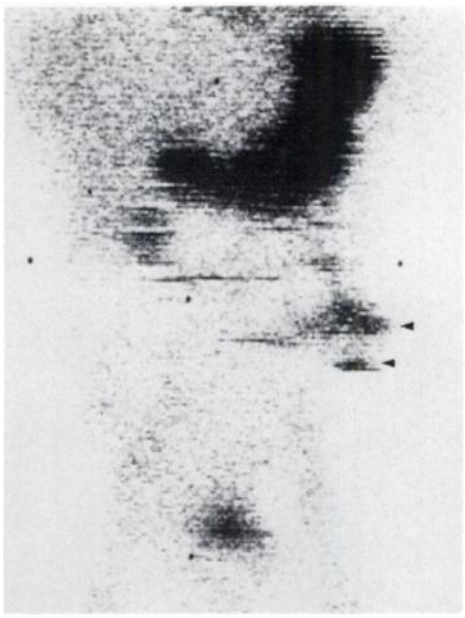

FIG. 3. Pertechnetate abdominal scan shows two areas of abnormal uptake in left upper quadrant (arrows). At laparotomy, several islands of ectopic gastric mucosa were identified in region corresponding to scan abnormalities. Scintigram after operation was normal.

FIG. 4. Pertechnetate abdominal scan shows large poorly defined area of activity in lower abdomen (arrow). This activity is too diffuse to be Meckel's diverticulum. No abnormalities were found at laparotomy.

DISCUSSION

Recent reports have emphasized the incidence of false-positive and false-negative studies in the detection of Meckel's diverticulum with pertechnetate scintigraphy (*6,10,11,14,15*). Rosenthall et al (*6*) used pertechnetate scans to study 45 children. Meckel's diverticulum was found in ten patients at operation; eight of the ten diverticula contained gastric mucosa, but only four were detected preoperatively. In our experience the only known false negative occurred where there was only a small amount of intact gastric tissue within the diverticulum.

The literature has also suggested several causes for false-positive studies, including obstruction of the small bowel, intussusception, hydronephrosis, and arteriovenous malformation. In intussusception, we have found the area of abnormal uptake to be larger than would be seen with Meckel's diverticulum (*4,5,9,10*). In our series we obtained negative scans in four cases of intussusception, four cases of arteriovenous malformations, and two cases of hydro-

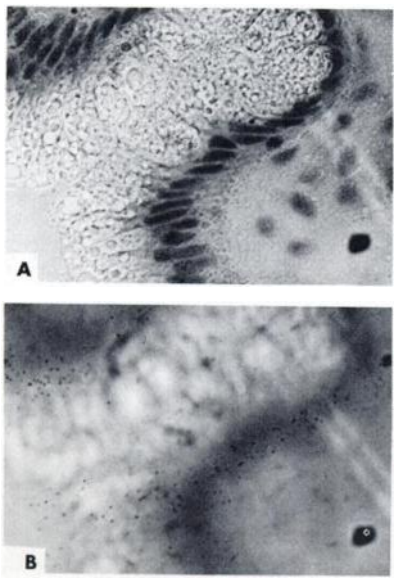

FIG. 5. Microscopic sections of canine gastric mucosa before (A) and after (B) injection of pertechnetate. Microscopic section obtained after injection shows numerous granules in superficial epithelial cells due to irradiation of emulsion by ^{99m}Tc.

nephrosis. The scan was positive in one patient with ectopic gastric mucosa in the ileum.

Thus, unless gastric mucosa was present, scans were negative. This correlates with the autoradiographic data, which showed pertechnetate concentration in the superficial epithelial cells only (Fig. 5). The mechanism for this uptake is not completely understood, but since these cells are present in all forms of gastric tissue, pertechnetate scanning should be of value in studies of any gastric tissue regardless of its location (*17–19*). Intestinal radioactivity seen in a scan may be either in the gut wall or in the lumen, and in time active material may be passed into the small bowel from the stomach. We found no technetium in the mucosa of the small or large bowel at 30 min after dosing, and only small amounts occurred there later. Clearly, a scan in search of Meckel's diverticulum should be done early (15 min or so after the dose) when neither the contents of the gut nor its normal mucosa will be contaminated with technetium. Kilpatrick (*13*) has used a scintillation camera for imaging Meckel's diverticulum since imaging can then be performed rapidly with little interference from uptake in the bladder or small bowel.

CONCLUSIONS

Pertechnetate is concentrated in the superficial epithelial cells of gastric mucosa. Knowledge of the concentrating cell type has enabled us to evaluate pertechnetate in the diagnosis of Meckel's diverticulum.

Preoperative diagnosis of Meckel's diverticulum was accomplished in five children and two adults using pertechnetate abdominal imaging. Localized islands of ectopic gastric mucosa in the ileum were detected in one additional patient. Of 33 patients who underwent laparotomy, one false-negative result occurred; in that instance only a small amount of intact gastric tissue remained in the diverticulum. We obtained negative scans in patients with arteriovenous malformations, intussusception, and hydronephrosis, all conditions suggested as possible causes of false-positive scans.

The diagnostic usefulness of pertechnetate in the detection of ectopic gastric mucosa is still in the early stages of evaluation. Although this technique has certain limitations, its value as a noninvasive aid in the diagnosis of Meckel's diverticulum has been established.

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