Technetium-99m pertechnetate imaging in diagnosis of Meckel's diverticulum

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Leonidas, J. C., and Germann, D. R. (1974). Archives of Disease in Childhood, 49, 21. Technetium-99m pertechnetate imaging in diagnosis of Meckel's diverticulum. Abdominal imaging after intravenous injection of 99mTc pertechnetate is a simple, safe, and noninvasive diagnostic procedure to show ectopic gastric mucosa, which is present in most cases of symptomatic Meckel's diverticulum. It was performed in 13 infants and children suspected of having a Meckel's diverticulum, mainly because of unexplained rectal bleeding. Two of the three proven Meckel's diverticula were correctly identified by scintiscanning, while meticulous contrast x-ray studies were negative in each case. It is concluded that abdominal imaging is useful in the pre-operative diagnosis of symptomatic Meckel's diverticulum.

Meckel's diverticulum is often asymptomatic; yet it may cause alarming symptoms in the presence of complications, such as haemorrhage, intussusception, or perforation (Gross, 1953). Bleeding from a Meckel's diverticulum is quite common in infants; it is the result of peptic ulceration at the junction between ectopic gastric and normal ileal mucosa (Gross, 1953; Longino and Holder, 1959). Pre-operative diagnosis is extremely difficult, and conventional x-ray studies are rarely successful in showing a Meckel's diverticulum (Sloan et al., 1954; Fortier-Beaulieu et al., 1969; Caffey, 1972). As a result, surgical exploration has been recommended in unexplained significant rectal bleeding in infants and children.

In the past 3 years a number of reports have indicated that ectopic gastric mucosa in a Meckel's diverticulum may be identified by radioisotope scanning or imaging (Jewett, Duszynski, and Allen, 1970; Rosenthal et al., 1972; Jaros, Schusheim, and Levy, 1973). The radionuclide technetium 99m (99mTc), resembling iodine in its biological properties, readily concentrates in gastric mucosa and appears in the gastric juice (Harden, Alexander, and Kennedy, 1967; Irvine et al., 1967). After intravenous injection of 99mTc pertechnetate, a Meckel's diverticulum containing ectopic gastric mucosa appears as an abnormal localization of the radiopharmaceutical. Since most symptomatic diverticula contain gastric mucosa, radionuclide imaging offers a quick, safe, and convenient method for the pre-operative investigation of patients suspected of having a Meckel's diverticulum at a low radiation exposure.

Since January 1972, radionuclide abdominal imaging has been performed in all infants and children presenting with symptoms consistent with a Meckel's diverticulum, and the results of this study are presented.

Material and methods

Between January 1972 and June 1973, 13 patients had radionuclide imaging studies in search of ectopic gastric mucosa, presumably in a Meckel's diverticulum. The records of clinical features, conventional contrast x-ray studies, and abdominal scans were studied. 4 of these patients had exploratory laparotomies and the surgical findings, as well as gross and histological features, were recorded.

Patients were injected intravenously with 100 µCi/kg body weight of 99mTc pertechnetate. Images of the abdomen were made at 15, 30, and 45 minutes after injection.* Early attempts at more delayed imaging were abandoned due to radioactivity moving from the stomach into the distal ileum.

Total body radiation dose is calculated to be 0.1 rads/mCi injected. This is in the same general range as a single abdominal x-ray exposure.

*All images were obtained with Nuclear of Chicago gamma camera, H-11 system.
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**TABI**

*Data in 13 cases of suspect*

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Sex</th>
<th>Age</th>
<th>Rectal bleeding*</th>
<th>Abdominal pain</th>
<th>Hb (g/100 ml)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>1 mth</td>
<td>+</td>
<td></td>
<td>16-4</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>7 yr</td>
<td>+</td>
<td>+</td>
<td>14-2</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>11 yr</td>
<td>+ +</td>
<td></td>
<td>11-8</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>1 dy</td>
<td>+</td>
<td></td>
<td>13-4</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>7 mth</td>
<td>+</td>
<td></td>
<td>10-4</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>9 yr</td>
<td>+</td>
<td>+</td>
<td>13-2</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>13 yr</td>
<td>+</td>
<td></td>
<td>14-2</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>9 mth</td>
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<td>7-8</td>
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<tr>
<td>9</td>
<td>F</td>
<td>6 mth</td>
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<td></td>
<td>3-9</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>3 yr</td>
<td>+</td>
<td></td>
<td>12-2</td>
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<td>11</td>
<td>F</td>
<td>18 mth</td>
<td>+ +</td>
<td></td>
<td>10-8</td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>11 mth</td>
<td>+ +</td>
<td></td>
<td>6-3</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>16 yr</td>
<td>+</td>
<td></td>
<td>12-6</td>
</tr>
</tbody>
</table>

*Number of (+) indicates number of admissions for rectal bleeding. †Hb in most recent admission. ‡Fetal Hb by Apt test.

**Fig. 1.—Case 13.** 16-year-old boy with severe abdominal pain. Barium was induced to reflux into ileum during barium enema examination. A large pouch was opacified connected to the small bowel by a narrow outlet, bearing features of a Meckel's diverticulum or an intestinal duplication.
Meckel’s diverticulum

<table>
<thead>
<tr>
<th>X-ray studies</th>
<th>99mTc abdominal imaging</th>
<th>Exploratory laparotomy</th>
<th>Histological examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>Not done</td>
<td>—</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
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<td>Negative</td>
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<tr>
<td>Negative</td>
<td>Negative</td>
<td>Not done</td>
<td>—</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>No Meckel's or other cause for bleeding found</td>
<td>—</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>Not done</td>
<td>—</td>
</tr>
<tr>
<td>Rapid colonic uptake of 99mTc</td>
<td>Meckel's diverticulum</td>
<td>Not done</td>
<td>Ectopic gastric mucosa</td>
</tr>
<tr>
<td>Lymphoid polyposis of colon</td>
<td>Meckel's diverticulum</td>
<td>Not done</td>
<td>Ectopic gastric mucosa</td>
</tr>
<tr>
<td>Positive</td>
<td>Meckel's diverticulum</td>
<td>Not done</td>
<td>Ectopic gastric mucosa</td>
</tr>
<tr>
<td>Positive</td>
<td>Meckel's diverticulum</td>
<td>Not done</td>
<td>—</td>
</tr>
</tbody>
</table>

There were no patients with documented Meckel’s diverticulum during the period of this study who did not have radionuclide studies.

Results

The findings in this group of 13 patients are presented in the Table. There were 6 males and 7 females, ranging in age from 1 day to 16 years. Since they were selected because they had abdominal scans with 99mTc pertechnetate, their symptoms were predictably those expected in Meckel’s diverticulum. 11 patients had significant rectal bleeding, usually recurrent (see Table). The blood was bright or dark red in 10 patients and black (melaena) in one infant (Case 4). It was often described as ‘soaking the diapers or clothing.’ 2 patients had no history of rectal bleeding. Case 13 had abdominal pain only, whereas one infant (Case 9) had unexplained iron deficiency anaemia. Abdominal pain was difficult to assess in small infants; pain was definitely present in 3 patients only.

Sigmoidoscopy was normal in every instance. Barium enema examination showed a large pouch arising from the ileum of Case 13 (Fig. 1). It had a narrow neck connecting it to the bowel, and in all respects it resembled a Meckel’s diverticulum, though a duplication could not be excluded altogether. In Case 10, a 3-year-old girl with repeated episodes of passing bright red blood from the rectum, barium enema showed the typical features of lymphoid hyperplasia (Capitanio and Kirkpatrick, 1970). In all other cases both barium enema and barium meal studies were within normal limits.

Radionuclide imaging with 99mTc pertechnetate was positive in 3 cases (Fig. 2, 3, and 4). In two of these cases subsequent laparotomy confirmed the presence of a Meckel’s diverticulum with ectopic gastric mucosa. In both cases conventional x-ray studies had been repeatedly negative during multiple hospital admissions. Case 13, a 16-year-old boy with abdominal pain and an ileal pouch on contrast x-ray study, also had a positive 99mTc scan. It was therefore concluded that the diverticulum contained ectopic gastric mucosa. The patient has refused surgery.

One patient with negative contrast x-ray studies

![Image](http://adc.bmj.com/)  
**FIG. 2.—** Case 13. 45-minute exposure during abdominal imaging after injection of 5 mCi 99mTc pertechnetate. Arrow indicates the area of high uptake in the midabdomen, representing ectopic gastric mucosa.
There is one case in this group (Case 13) who had a diverticulum arising from the ileum on barium study; gastric mucosa in an ectopic location was shown by 99mTc scanning. It certainly represented either a Meckel’s diverticulum or a duplication with ectopic gastric mucosa, but surgical and histological confirmation was lacking.

**Discussion**

Pre-operative diagnosis of Meckel’s diverticulum is notoriously difficult, and in the majority of patients who present with symptoms consistent with this entity, surgical exploration is ultimately performed. In most cases, however, no definite cause for the clinical manifestations is found, and surgery proves unnecessary (Jaros et al., 1973).

Abdominal rectilinear scanning, or imaging with the γ-ray scintillation camera, after intravenous injection of 99mTc pertechnetate has been shown thus far to be valuable in the identification of ectopic gastric mucosa. Though most Meckel’s diverticula do not contain gastric mucosa, it is the latter that is implicated in the majority of symptomatic cases (Rutherford and Akers, 1966). Consequently the diagnostic value of radionuclide studies increases considerably.

Early scans show a high uptake of the radiopharmaceutical by the stomach, and relatively large amounts are seen in the proximal duodenum. The liver and kidneys may also be identified in initial scans, and the bladder remains ‘hot’ throughout the examination (Duszynski, 1972). These organs are easily identified by their position and configuration and do not interfere with the focus of high isotope activity seen in the midabdomen, usually to the right, when ectopic gastric mucosa is present (Fig. 2, 3, 4). If the bladder is full and its activity occupies a significant part of the lower abdomen, it should be emptied.

Radiopertechnetate has been used in the diagnosis of Meckel’s diverticulum only since 1970 (Jewett et al., 1970). The largest published series is that of Rosenthal et al. (1972) who studied 45 children, of whom 10 had proven Meckel’s diverticulum. Of these, 8 were found to have gastric mucosa and 4 of them gave positive scans. In the present series 2 of 3 cases were correctly diagnosed before operation. Thus, a simple, safe, and noninvasive procedure is only slightly inferior in accuracy to surgical exploration. In the present series, however, operation was decided on the basis of the radioisotope scan findings, and it might have been less successful without its benefit. Surgical exploration has been unrewarding in the past in the investigation of rectal bleeding in infants and children.
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Fig. 4.—Case 12. (a) 15-minute exposure during abdominal imaging shows abnormal localization of 99mTc in area of ectopic gastric mucosa (black arrow). Note also high uptake by the stomach and liver. (b) 45-minute exposure shows further concentration of 99mTc by the ectopic gastric mucosa (black arrow). White arrows point to radiopharmaceutical in the jejunum (upper arrow) and bladder (lower arrow). A Meckel's diverticulum was resected at operation.

One false negative scan in this series remains unexplained. Rosenthal et al. (1972) list several factors to account for false negative results in the presence of gastric mucosa. They include superimposed inflammation, haemorrhage, obstruction of the sac outlet with back-pressure prevention of uptake, and insufficient amount of gastric mucosa. There were no false positive cases in this series. Localized bowel irritation or inflammation, however, and intussusception may give high uptake of 99mTc (Duszynski, 1972) and radioisotope scans should be interpreted in conjunction with the clinical and radiological features.

Differential diagnosis between a Meckel's diverticulum and an intestinal duplication containing gastric mucosa is impossible, as exemplified by Case 13. Such differentiation would be, however, academic, since for all practical purposes both lesions are of similar clinical significance and should be managed the same way.

In the patients not operated upon we can only assume that no Meckel's diverticulum exists. There has been no recurrence of rectal bleeding in the majority of these children (Table) and all of them have been symptom-free for at least 6 months, and most of them for over one year.

In conclusion, considering the very low yield of other diagnostic methods including fluoroscopy and radiography in Meckel's diverticulum, 99mTc pertechnetate imaging is probably the most effective diagnostic technique today. Its accuracy, convenience, and radiation exposure compare favourably with conventional radiological investigation, and it is hoped that its use will lead to an earlier and more accurate diagnosis of Meckel's diverticulum and reduce the number of unnecessary operations.

REFERENCES


Leonidas and Germann


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