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REVIEW ARTICLE

# Detection of ectopic gastric mucosa using $^{99m}$Tc pertechnetate: review of the literature

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**Abstract** Technetium-99m ($^{99m}$Tc) pertechnetate scintigraphy in a child with acute gastrointestinal bleeding of unknown origin suggests ectopic gastric mucosa caused by Meckel's diverticulum or gastrointestinal duplication cysts. Our objective was to define the patterns of scintigraphic findings likely to be encountered in patients with ectopic gastric mucosa with illustrative cases and to review the literature. Fifty children (age 1 year to 14 years) were evaluated for ectopic gastric mucosa using $^{99m}$Tc pertechnetate scintigraphy. Functioning ectopic gastric mucosa was detected in eight patients with Meckel's diverticula and three patients with bowel duplication. Three patients showed atypical findings on scintigraphy which were perforated appendix, calyceal stasis, and regional enteritis. Ectopic functioning gastric mucosa in Meckel's diverticulum is visualized simultaneously with the stomach, whereas in intestinal duplications tracer activity can be visualized in the dynamic sequence or before gastric tracer visualization in an irregular pattern. A variety of scintigraphic patterns can be found in patients with ectopic gastric mucosa undergoing $^{99m}$Tc pertechnetate scintigraphy depending on the location and size of the ectopic tissue. Also, acquisition of delayed images is useful when the initial images are equivocal in children.

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## Introduction

Ectopic gastric mucosa (EGM) is most commonly found in Meckel's diverticulum (MD), and 50% of these patients have symptoms of gastrointestinal bleeding, obstruction, diverticulitis, or umbilical abnormalities. The prevalence of EGM in MD approaches 100%, if the patient population is limited to those who have symptoms [1]. The other possible locations of EGM, although rare, are the intestinal duplications and the small bowel.

Radionuclide imaging using technetium-99m pertechnetate ($^{99m}TcO_4^-$; Meckel's scan) is a well-established diagnostic technique to evaluate children with lower gastrointestinal bleeding [2]. $^{99m}$Tc pertechnetate is taken up and secreted by the tubular glands of the gastric mucosa. The affinity of $^{99m}TcO_4^-$ for gastric mucosa makes this radiopharmaceutical a valuable tool to detect EGM. There is a wide range of sensitivity of $^{99m}TcO_4^-$ scintigraphy for the diagnosis of EGM in the literature. It has been reported to be 85–91% by Sfakianakis et al. [2, 3] and 81% by Kong [4], whereas Fries et al. [5] reported the sensitivity to be as low as 50%. Likewise Dixon et al. [6] and Schwarz et al. [7] reported a lower sensitivity from their analysis of $^{99m}TcO_4^-$ scintigraphy in surgically proven cases with EGM. In the last decade, novel molecular mechanisms of $^{99m}TcO_4^-$ uptake via sodium iodide symporter system (NIS) has been clarified. NIS is a transmembrane transport system that modulates intracellular transport and accumulation of iodine to some tissues mainly including

the thyroid, stomach, salivary glands, and to some extent the small intestine. Besides iodine, $^{99m}TcO_4^-$ is also taken up by thyroid follicular cells as well as epithelial cells lining the mucosal surface of the stomach and proximal small intestine. Uptake of $^{99m}TcO_4^-$ by EGM also depends on the presence of NIS on the mucosal cells, which behave like gastric mucosal cells [8]. Mucosal cells accumulate $^{99m}TcO_4^-$ via NIS and secrete it into mucus. Therefore, $^{99m}TcO_4^-$ activity in the stomach and proximal small intestine depends on both uptake via NIS and secretion into the lumen of these hollow organs [8].

In this article, we aimed to highlight the spectrum of scintigraphic findings likely to be encountered in patients with EGM with illustrative cases. In addition, we discuss the technical aspects, the cellular site of $^{99m}TcO_4^-$ uptake, and the role of pharmacological enhancement and utility of delayed imaging.

## Materials and methods

Records of 50 children, who were referred for a scintigraphic evaluation of a possible EGM using $^{99m}TcO_4^-$ during a 5-year period, were reviewed retrospectively. Demographic data of the patients' age at presentation and sex, major presenting symptoms (gastrointestinal bleeding, bowel obstruction, inflammation, or others) and results of $^{99m}TcO_4^-$, and if present histological findings were recorded (Table 1).

### Meckel's scintigraphy

All patients were asked to fast for 3–4 h before the scan. They were given ranitidine, 1 mg/kg with slow infusion to block secretion from the cells and increase gastric mucosa uptake before an intravenous administration of 3.7 MBq/kg $^{99m}TcO_4^-$. Patients were imaged using a dual-headed gamma camera (Siemens Ecam, IL, USA) mounted with low-energy all-purpose collimators positioned over the abdomen and pelvis. Dynamic images of 1 min were obtained for 40 min. Additional anterior–posterior, lateral images spot views were obtained. Delayed imaging in the post-void state was also performed. The images were reviewed by the nuclear medicine physicians in a format of 2 min compressed views.

The final diagnosis was decided on the basis of operative findings and subsequent histology.

## Results

Of 50 patients, 14 underwent surgery, all but one of whom (case no. 13) had abnormal findings on scintigraphy. The remaining cases ($n$ = 36) were accepted as normal and did not undergo surgery. The diagnosis of EGM on $^{99m}TcO_4^-$ scintigraphy was based on the appearance of the radiotracer activity at an ectopic location, simultaneously with the presence of gastric activity which increased in intensity with time.

In cases 1 to 5, scintigraphy revealed abnormal tracer uptake in a local area in the mid-lower abdomen in the early images, which appeared simultaneously with the gastric uptake, and persisted in the delayed images (Fig. 1). On the basis of these findings, a diagnosis of MD with EGM was made. In case 6, a faint uptake was observed on the dynamic images which was equivocal for EGM (Fig. 2a). A delayed image 30 min after the dynamic imaging revealed an intense uptake and confirmed the finding (Fig. 2b).

**Table 1** Scintigraphic patterns of ectopic gastric mucosa, their relation to appearance of tracer in the stomach, and final diagnosis

| Case | Age | Relation to appearance of tracer in the stomach on scintigraphy | Final diagnosis |
|---|---|---|---|
| 1 | 2 y | Focal simultaneous | Meckel's diverticulum |
| 2 | 9 y | Focal simultaneous | Meckel's diverticulum |
| 3 | 8 y | Focal simultaneous | Meckel's diverticulum |
| 4 | 2 y | Focal simultaneous | Meckel's diverticulum |
| 5 | 5 y | Focal simultaneous | Meckel's diverticulum |
| 6 | 9 y | Focal simultaneous | Meckel's diverticulum |
| 7 | 16 m | Nonhomogenous simultaneous | Infected Meckel's diverticulum |
| 8 | 11 y | Focal simultaneous | Meckel's diverticulum with pancreatic tissue |
| 9 | 11 y | Irregular simultaneous | Intestinal duplication |
| 10 | 12 y | Irregular simultaneous | Intestinal duplication |
| 11 | 7 m | Irregular simultaneous | Intestinal duplication |
| *False cases* | | | |
| 12 | 5 y | Linear before, no change in intensity | Regional enteritis |
| 13 | 5 y | Focal simultaneous, change in intensity | Calyceal/activity |
| 14 | 5 y | Minimal atypical uptake | Perforated appendix |

*y* years, *m* months

Nonhomogeneous low-intensity accumulation of radioactivity was observed in the midline of the lower abdomen in case 7, which did not show considerable change during the study (Fig. 3a, b). The resection material revealed infected MD (Fig. 3c).

In case 8, focal uptake of radioactivity was seen in the right lower abdominal region following the accumulation of activity in the gastric region (Fig. 4a). The resection material revealed pancreatic tissue as well as gastric tissue in the mucosa and submucosa of an MD (Fig. 4b, c).

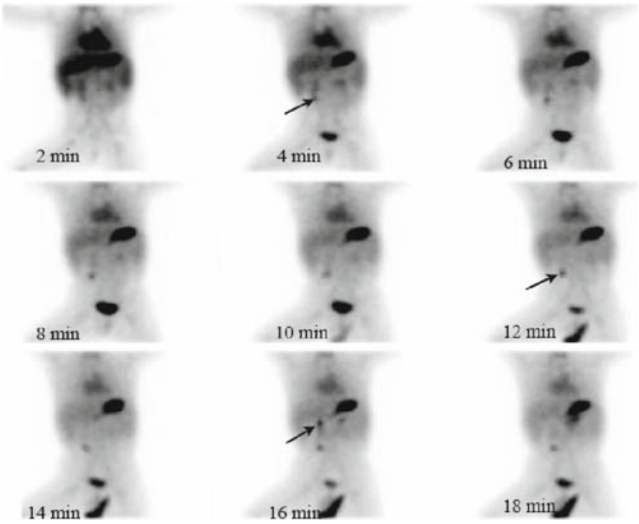


**Fig. 1** Dynamic technetium-99m pertechnetate ($^{99m}TcO_4^-$) scintigraphy images show focal area of intense abnormal tracer accumulation in the mid-lower abdominal area appearing at the same time as gastric mucosal uptake in a 2-year-old girl (case 1). This pattern is a characteristic of Meckel's diverticulum (MD; *arrow*, on 4-min and 12-min images). Also note the focal transitory uptake superior to that, which is renal calyx activity (*arrow*, on 16-min image)

Dynamic images showed a blush of tracer activity in the abdomen in case 9 (Fig. 5a, b) and in case 10 where subsequent static images revealed accumulation with intensity equal to those of gastric mucosa. An irregular activity in the lower abdomen before the visualization of tracer activity in the stomach was seen in case 11 (Fig. 6), with consequent static images revealing intense accumulation. Surgery was performed on these patients and intestinal duplication with ectopic functioning gastric mucosa was diagnosed.

In cases 12–14, findings were abnormal either on the dynamic and/or delayed images on $^{99m}TcO_4^-$ scintigraphy. However, the findings were not specific for scintigraphic criteria of EGM, and either delayed imaging or the histopathological findings showed that they were actually not related to EGM. In case 12, bilateral linear foci of tracer accumulation were observed prior to gastric uptake and showed no significant change during the study (Fig. 7a, b). Because the findings were nonspecific for EGM, a colonoscopy was performed but revealed no pathology. The patient underwent surgery for an evaluation as his complaints continued, and the biopsy material showed regional enteritis.

Case 13 showed that the steady tracer localization was owing to radioactivity stasis in a dilated calyx on the dynamic images which was relieved on delayed image following injection of a diuretic (Fig. 8a, b). Although this case was reported as unimpressive for MD, the

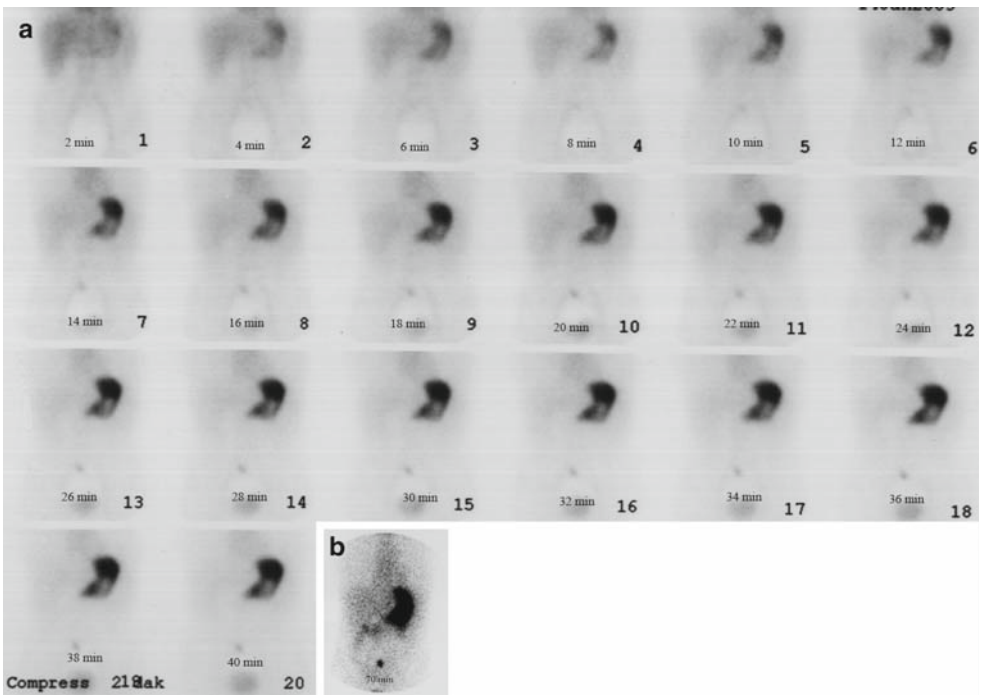


**Fig. 2** The dynamic images of case 6 obtained every 2 min show minimal focus of radiotracer activity in the lower abdomen (**a**) which became clear on the delayed image taken at 70 min (**b**)

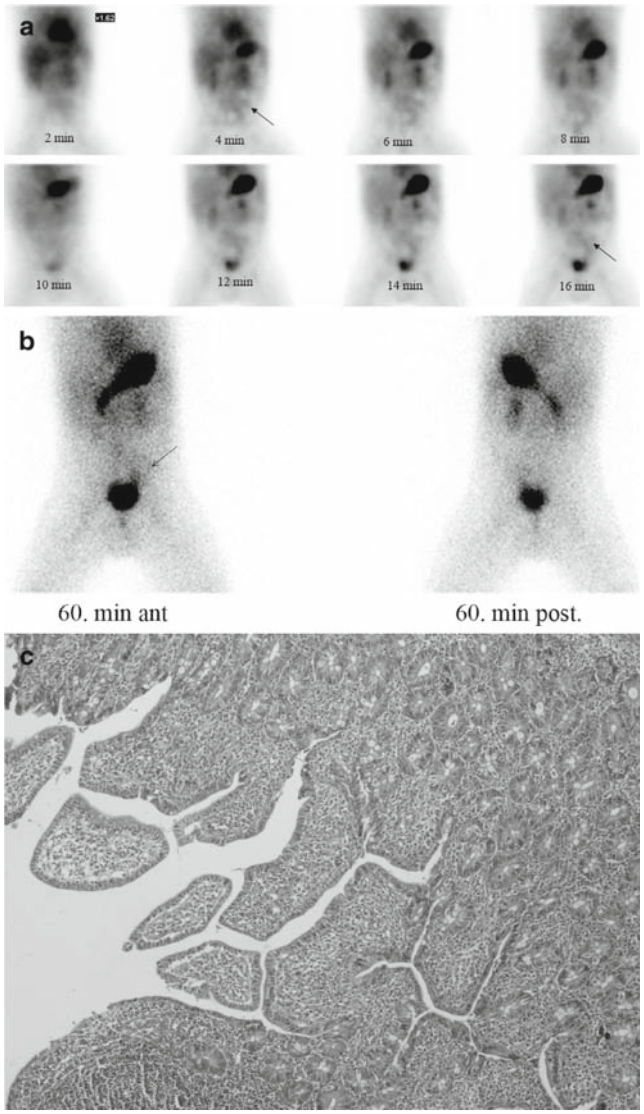


**Fig. 3** **a** A 16-month-old male patient (case 7) with blood in the stool underwent ultrasonography where a cystic tissue was seen superior to the bladder. On the scintigraphic images, an irregular uptake of radioactivity was observed superior to the bladder, which did not change throughout the study and on the delayed image at 60 min (**b**). It was considered to be atypical for MD, but the surgical specimen revealed that it was an infected MD. **c** Mononuclear inflammatory infiltrate and a lymphoid follicle (*lower left*) in the mucosa of MD [hematoxylin and eosin (HE), ×100]

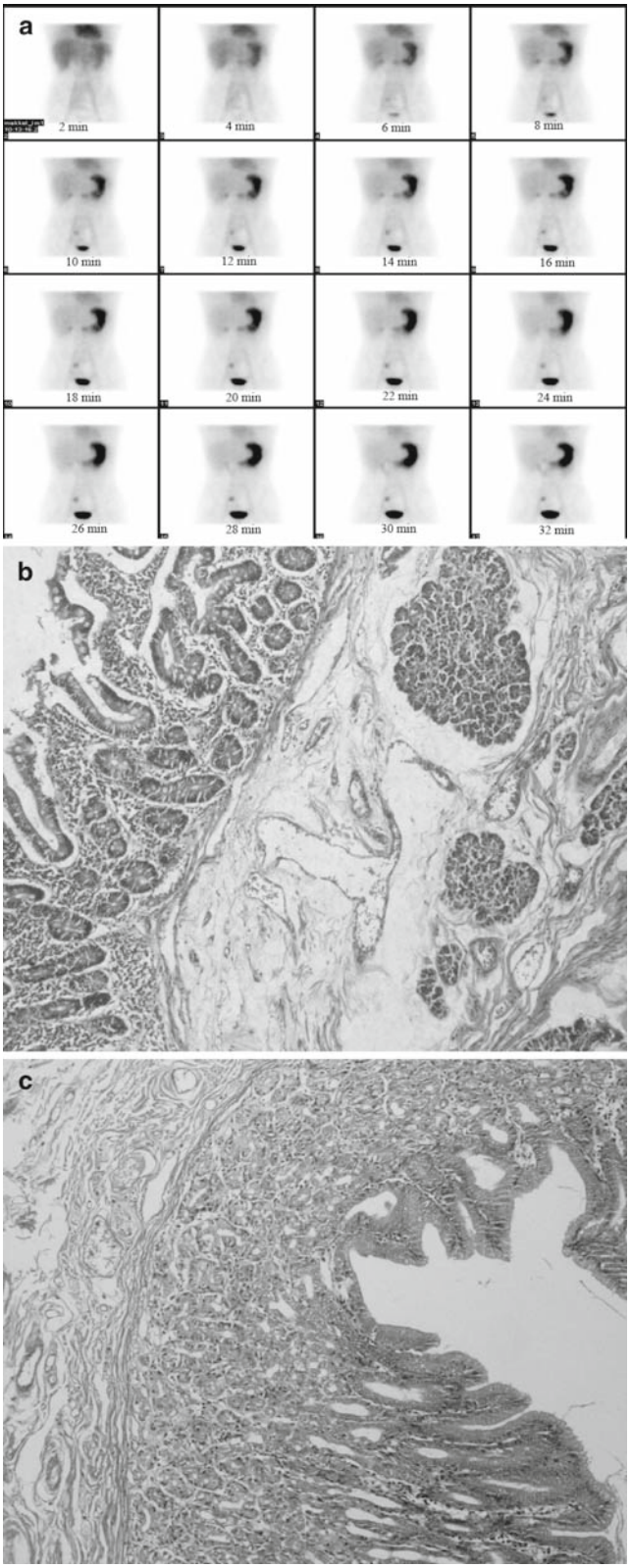


**Fig. 4** **a** An 11-year-old male patient (case 8) with complaints of rectal bleeding for a week was referred to the nuclear medicine department for scintigraphy. On early images, a blush of radioactivity was observed in the infra-umbilical region which disappeared and was transformed to focal tracer accumulation. Abdominal ultrasonography was normal. The surgical material revealed it to be MD with gastric mucosa and ectopic pancreatic tissue. **b** Pancreatic tissue in the submucosa of MD lined by intestinal epithelium (HE, ×100). **c** MD lined by metaplastic corpus mucosa (HE, ×100)

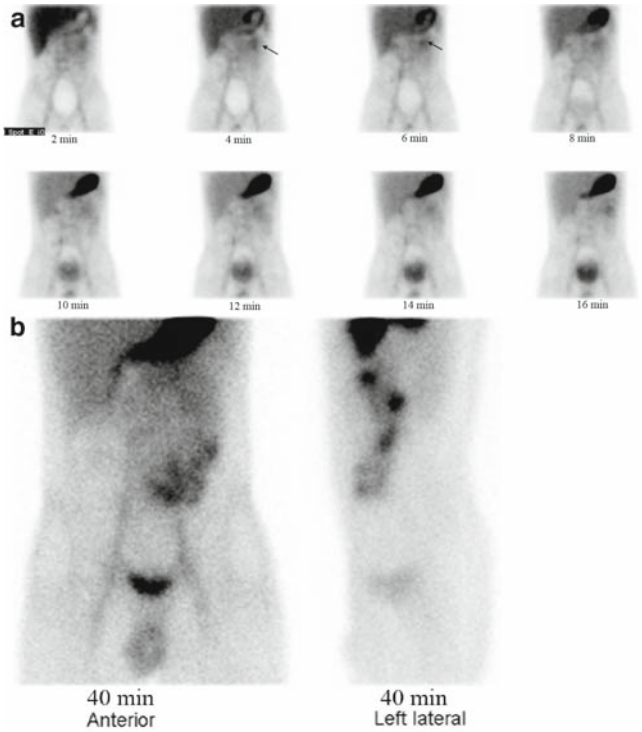


**Fig. 5** **a** Tc-99m pertechnetate scintigraphy was performed on an 11-year-old male patient (case 9) who had bleeding after defecation a couple of months previously which repeated several times. The dynamic images show an abnormal tracer accumulation in the left mid-lower abdominal area appearing at the same time as gastric mucosal uptake (*arrows*). **b** This was progressively increasing in intensity, clearly seen on the delayed image at 40 min on anterior and left lateral views. The patient underwent surgery and the final diagnosis was intestinal duplication

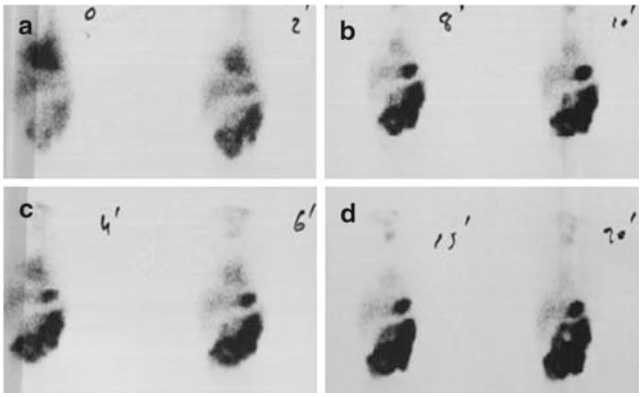


**Fig. 6** A 7-month-old female patient (case 11) with bleeding symptoms was referred for a scintigraphic evaluation after a non-diagnostic abdominal tomography. Intestinal accumulation of radioactivity was observed in the left lower abdominal region with an increasing intensity before the gastric uptake. The biopsy specimen revealed that it was intestinal duplication

patient underwent surgery on demand of the referring pediatrician. Histopathology revealed no signs of EGM.

Faint uptake of the tracer on the dynamic images in the right lower location of the abdomen in case 14 was considered to be suspicious for EGM. The surgical specimen revealed that it was owing to a perforated appendix (Fig. 9a, b).

## Discussion

Ectopic gastric mucosa may cause gastrointestinal bleeding and severe complications. A variety of congenital gastrointestinal malformations are associated with EGM. These include MD and intestinal duplication.

Meckel's diverticulum is the most common congenital anomaly of the gastrointestinal tract. It is seen in 1–3% of the population and is caused by failure of the omphalomesenteric duct to regress. The point of attachment of an MD to the bowel varies. It is commonly found within 50–100 cm of the ileocecal valve [1]. Painless gastrointestinal bleeding is a common presentation of MD in children younger than 5 years. It may become symptomatic in older children or adults; in this case, there is a higher likelihood of presentation with obstruction (intussusceptions or volvulus) or inflammatory complications (including perforation). The likelihood of finding EGM in MD is as high as 65–90% in symptomatic patients [1]. Cases 1–5 illustrate the classical scintigraphic findings of MD with functioning EGM.

There is limited knowledge on infected MD in the literature [9, 10]. There has been considerable controversy regarding both the presence and significance of organisms in MD. Hill et al. [9] showed that diverticulum was lined by gastric body type mucosa showing evidence of active chronic gastritis associated with the presence of organisms, identified immunohistochemically. An active chronic gastritis present within the gastric body type mucosa may suggest that organisms play a pathogenic role. In case 7, a nonhomogeneous low-intensity accumulation of radioactivity was observed in the midline of the lower abdomen, which did not show considerable change during the study (Fig. 3a, b). The resection material revealed the presence of EGM as well as mononuclear cell infiltration (Fig. 3c). This atypical uptake of radioactivity might occur secondary to damage to the NIS function of the EGM from the infection. On the other hand, the presence of severe inflammation may cause nonspecific activity accumulation owing to hypervascularity, increased blood pool, and/or elevated permeability. To the best of our knowledge, there is no similar scintigraphic image for an infected MD in the literature, but this scintigraphic pattern does not allow us to make a differential diagnosis either.

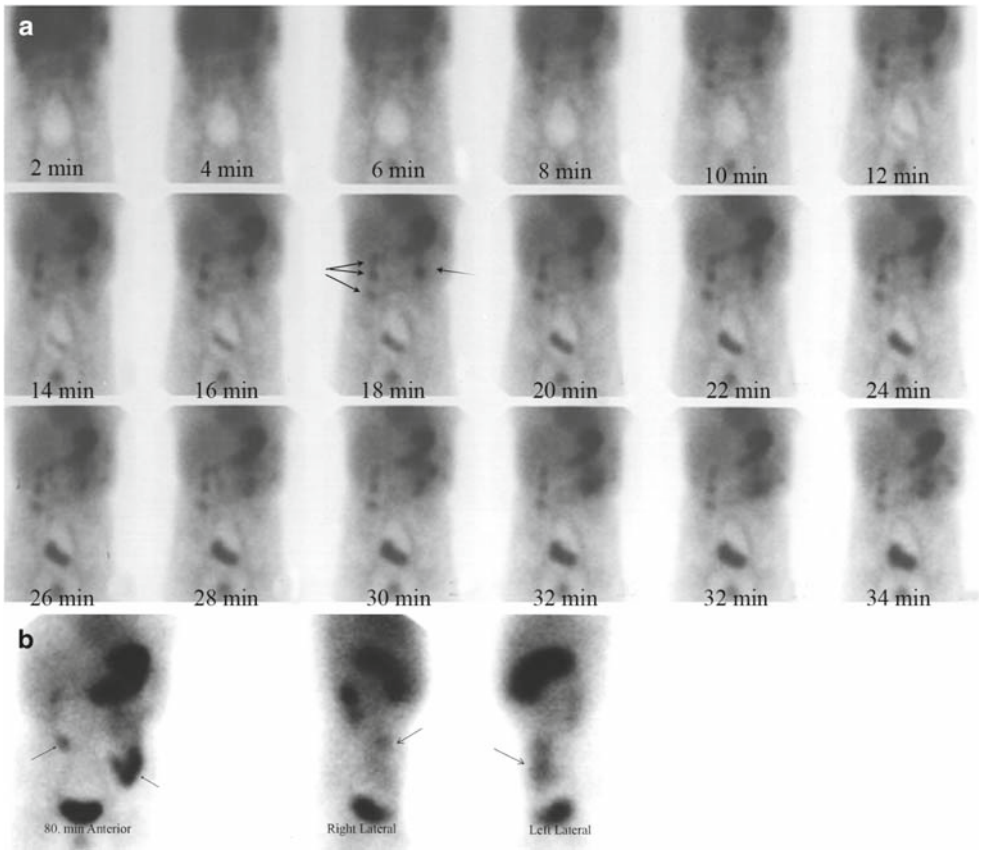


**Fig. 7** **a** A 5-year-old male patient (case 12) with a history of rectal bleeding 2 months previously lasting for 4 days was referred for scintigraphic evaluation. On dynamic evaluation, three foci of activity were noted vertically in the right, and a single focus of activity was seen below the gastric region (*arrows*). The delayed image obtained at 80 min showed conglomerous accumulation of radioactivity on the left and a small focus of activity on the right (*arrows*, **b**). The biopsy specimen revealed that it was owing to regional enteritis

Meckel's diverticulum is the tissue that has EGM, which makes it visible on $^{99m}TcO_4^-$ scintigraphy. If there is no or insufficient gastric mucosa it will not be possible to visualize it. On the other hand, other ectopic tissues can be found in MD. Pancreatic tissue is one of the ectopic tissues that has been reported in the literature [11]. The presence of ectopic tissue in patients with MD seems to be associated with more at risk for occurrence of an acute nonmechanical complication, particularly in young patients [12]. The case presented in this work was referred because of bleeding and showed focal simultaneous accumulation of the radioactivity.

Gastrointestinal duplications are uncommon congenital lesions with no known etiology [13]. They are seen in 1 of every 4500 autopsies [1]. It is diagnosed in 80% of the patients before 2 years of age. The presenting symptoms are painless bleeding, intestinal obstruction, or a palpable mass [14]. These symptoms depend on the location, size, and presence of gastric mucosa which is present in 20%–30% of them [13, 15]. Majority of the cases are present in the ileum, but they may arise at any level of the intestine. Multiple sites may be involved in 15% of the cases. The lumen of the duplication usually is not in continuity with the normal intestine. Gastric mucosa may line the wall of the duplication which may predispose to ulceration and fistulization to the adjacent bowel with bleeding or free perforation into the peritoneum. We had three cases of ileal duplication cysts with accumulation of $^{99m}TcO_4^-$ appearing at the same time with the uptake in the stomach in two of them, whereas one case showed uptake prior. Kumar et al. [16] has reported that ileal duplications with EGM were seen simultaneously with the stomach.

Meckel's diverticulum and intestinal duplication should be included as differential diagnostic possibilities for a focus of increased activity on $^{99m}TcO_4^-$ scintigraphy, because they cannot be distinguished on the basis of the size or location of EGM. As both conditions are managed surgically, preoperative differentiation is not important. During surgery, they are easily differentiated because MD is located on the antimesenteric border of the bowel, whereas duplication is located on the mesenteric side of the bowel.

Jewett et al. [17] made possible the use of $^{99m}TcO_4^-$ for the noninvasive diagnosis of MD with EGM. Intravenously injected pertechnetate accumulates in the gastric mucosa, thyroid gland, salivary glands, and choroid plexus and some is excreted by the kidneys. A normal abdominal $^{99m}TcO_4^-$ study should not show any focal tracer accumulation other than in the stomach and

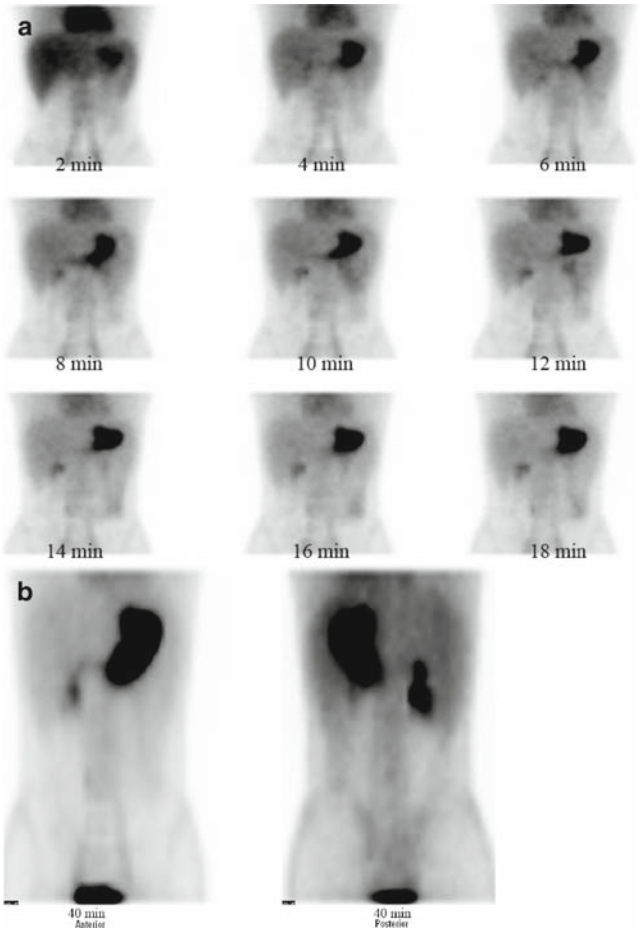


**Fig. 8** A focal area of radioactivity accumulation was observed on the right side of the abdomen almost consecutively with the gastric activity in a 5-year-old male patient (case 13) with complaints of anemia and abdominal pain. A delayed imaging revealed calyceal stasis of the activity especially on the posterior view. Although the scintigraphic interpretation was inconclusive for MD, the patient underwent surgery on the demand of the referring physcian. No abnormal findings on histopathology were observed

urinary tract. Some tracer may be seen in the bowel later in the course of the study as a result of gastric emptying.

Several articles discuss pharmacological intervention using pentagastrin, histamine-2 (H-2) blockers such as cimetidine or ranitidine, and glucagon to enhance the accuracy of $^{99m}TcO_4^-$ scintigraphy for the detection of EGM. Pentagastrin, the *N*-terminal 5-amino acid residue of gastrin, is a potent stimulator of acid secretion from the parietal cells [18]. In an animal study [3], pentagastrin increased gastric motility, leading to rapid tracer accumulation in the small bowel with a concomitant increase in background and thus causing an inconclusive result. In contrast, H-2 blockers, by inhibiting the acid secretion reduce the washout and cause retention of $^{99m}TcO_4^-$ in the gastric glands and enhance visualization of EGM [19]. Glucagon, by its antiperistaltic effect, prevents rapid washout of pertechnetate from the stomach or from the area of EGM [20]. It also prevents movement of EGM during examination and thus will increase its detectability. In our routine practice, we prefer using H-2 blockers before administration of $^{99m}TcO_4^-$.

Pitfalls in the interpretation of $^{99m}TcO_4^-$ scintigraphy:

Causes of false-positive results noted in the literature include [2, 21, 22]:

- intussusception
- bowel inflammation (Fig. 7)
- gastrointestinal bleeding unrelated to EGM
- uterine blush
- retention of tracer in the urinary collecting system (Fig. 8)
- vascular lesions such as hemangiomas
- arteriovenous malformations.

False-negative $^{99m}TcO_4^-$ scintigraphy may result from [23]:

- the small size of the island of EGM, an estimation of lesions' size of at least 1 $cm^2$ is required for a Meckel's scan [20].
- technical factors: planar imaging may have difficulties in the detection of EGM owing to uncertainty in localization or lower contrast which can be overcome by single-photon emission computed tomography (SPECT) or SPECT-computed tomography (CT) imaging [24]. This may also enable detection of smaller amounts of gastric mucosa.
- the absence of EGM in MD. Although majority of patients with bleeding symptoms are reported to have EGM in MD, some other ectopic tissues such as pancreatic tissue in the MD may also cause symptoms owing to intestinal obstruction and/or bleeding [12].
- residual contrast in bowel from previous barium studies may hinder detection of EGM.
- tracer in the urinary bladder may obscure a focus of EGM if it is located near the bladder.

In a study by Kumar et al. [16], different scintigraphic patterns of EGM were highlighted and several interesting cases were presented. One might consider that these two studies resemble each other, but there are major methodological differences between them. First of all, we tried to define common false-positive/-negative causes for scintigraphic evaluation of EGM and categorized the patients depending on the presence of EGM as to whether they are in MD or duplication. Moreover, every patient included in our study underwent MD scintigraphy according to the standard procedure guidelines [25], which suggest the use of pharmacological intervention to increase the diagnostic sensitivity. Whereas Kumar

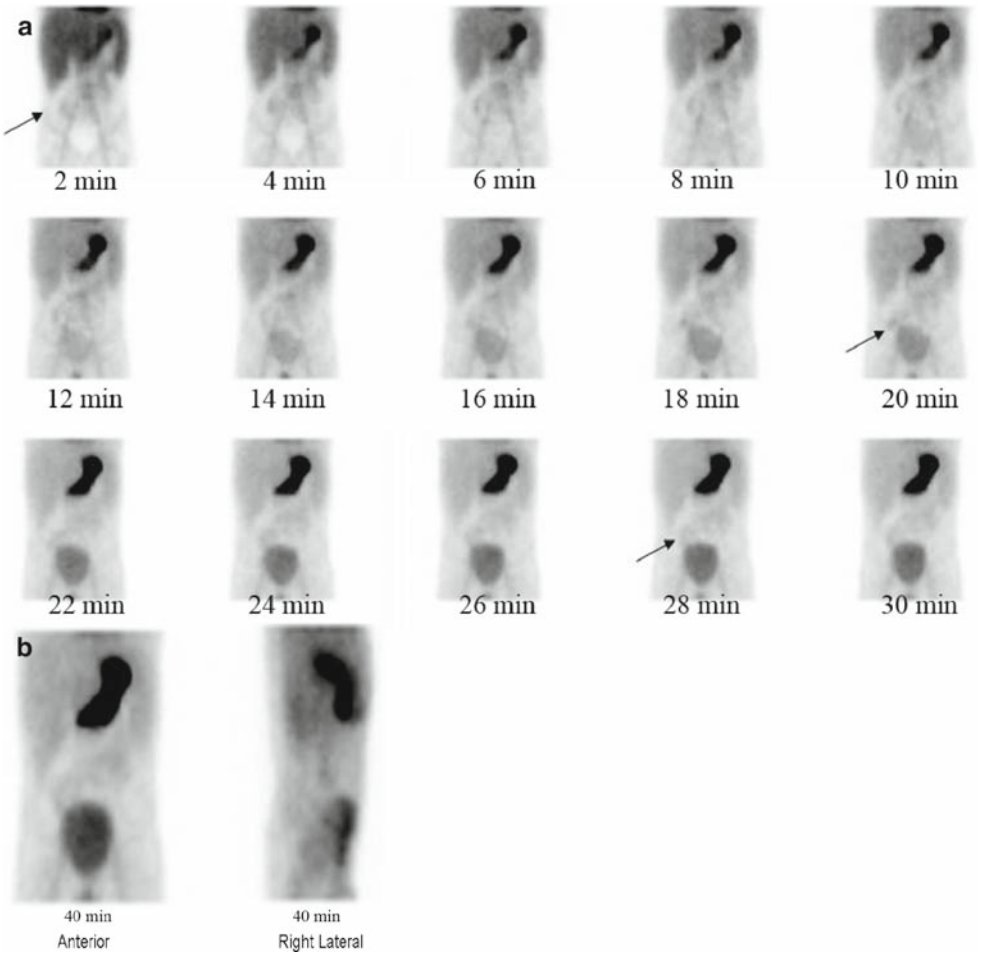


**Fig. 9a,b** A 5-year-old male patient (case 14) with complaints of increasing pain in the lower abdomen and blood in the stool underwent scintigraphy for the possibility of ectopic gastric mucosa. A minimal blush of activity was observed in the right lower abdominal region, which faded during the dynamic imaging (*arrows*) and on the static views. The patient was operated on, and a perforated appendix was found

et al. [16] stated that none of their patients had any pharmacological intervention for MD scintigraphy and they presented a different protocol of their institution for the children with thoracic cysts, who may also possibly have intestinal duplication cysts which might decrease the presence of their EGM detection rate.

In our study, three cases had abnormal findings either on the dynamic and/or delayed images on $^{99m}TcO_4^-$ scintigraphy, and either delayed imaging or the histopathological findings showed that they were false-positive findings.

To avoid either false positives or negatives, one must recognize the normal findings in $^{99m}TcO_4^-$ scintigraphy. Continuous imaging, however, will show a focal increased uptake low in the pelvis before any tracer appears in the bladder. In questionable cases, a postvoid image or diuretic administration may be helpful. Preferably, no barium studies should have been performed within 24 h of the scan. Cleansing enemas or laxatives must be avoided before examination if possible because they may cause bowel irritation and may interfere with the detection of a focus of EGM. Also use of perchlorate as pretreatment which may lead to decreased gastric uptake should be avoided.

In conclusion, a variety of scintigraphic patterns may be found in patients with EGM undergoing $^{99m}TcO_4^-$ scintigraphy, depending on the location and size of the ectopic tissue. Ectopic-functioning gastric mucosa in MD and duplication are visualized simultaneously with the stomach whereas in intestinal duplications tracer activity can be visualized in the dynamic sequence and even prior to gastric tracer visualization.

## References

1. Amoury RA, Snyder CL. Meckel diverticulum. In: O'Neill JA, Rowe MI, Grosfeld JL, et al., editors. Pediatric surgery. St. Louis: Mosby-Year Book; 1998, p. 1173–84.
2. Sfakianakis GN, Haase GM. Abdominal scintigraphy for ectopic gastric mucosa: a retrospective analysis of 143 studies. Am J Roentgenol 1982;138:7–12.
3. Sfakianakis GN, Conway JJ. Detection of ectopic gastric mucosa in Meckel's diverticulum and in other abnormalities by scintigraphy. II. Indications and methods: a 10-year experience. J Nucl Med 1981;22:732–8.

4. Kong MS. Technetium pertechnetate scan for ectopic gastric mucosa in children with gastrointestinal bleeding. J Formos Assoc 1993;92:717–20.
5. Fries M, Mortensson W, Robertson B. Technetium pertechnetate scintigraphy to detect ectopic gastric mucosa in Meckel's diverticulum. Acta Radiol Diagn 1984;25:417–22.
6. Dixon PM, Nolan DJ. The diagnosis of Meckel's diverticulum: a continuing challenge. Clin Radiol 1987;38:615–9.
7. Schwartz MJ, Lewis JH. Meckel's diverticulum pitfalls in scintigraphic detection in the adult. Am J Gasteroenterol 1984;79: 611–8.
8. Luckier LS, Dohan O, Li Y, Chang CJ, Carrasco N, Dadachova E. Kinetics of perrhenate uptake and comparative biodistribution of perrhenate, pertechnetate and iodide by NaI symporter-expressing tissues in vivo. J Nucl Med 2004;45: 500–7.
9. Hill P, Rode J. *Helicobacter pylori* in ectopic gastric mucosa in Meckel's diverticulum. Pathology 1998;30:7–9.
10. Morris A, Nicholson G, Zwi J, Vanderwee M. *Campylobacter pylori* infection in Meckel's diverticula containing gastric mucosa. Gut 1989;30:1233–5.
11. Maggi G, Navarra L, Cianca G, Vittorini V, Ciccarelli O, Pietroletti R, et al. Ectopic pancreas in Meckel's diverticulitis: a description of a new clinical case. Ann Ital Chir 2002;73: 647–9.
12. Artigas V, Calabuig R, Badia F, Rius X, Allende L, Jover J. Meckels diverticulum: value of ectopic tissue. Am J Surg 1986; 151:631–4.
13. Gross RE, Holcomb GW Jr, Farber S. Duplications of the alimentary tract. Pediatrics 1952;9:449–52.
14. Holcomb GW III, Gheissari A, O'Neill JA Jr, Shorter NA, Bishop HC. Surgical management of alimentary tract duplications. Ann Surg 1989;209:167–74.
15. Bond SJ, Groff DB. Gastrointestinal duplications. In: O'Neill JA Jr, Rowe MI, Grosfeld JL, Fonkalrud EW, Coran AG, editors. Pediatric surgery, vol. 2, 5th ed. St Louis: Mosby; 1998. p. 1257–67.
16. Kumar R, Tripathi M, Chandrashekar N, Agarwala S, Kumar A, Dasan JB, et al. Diagnosis of ectopic gastric mucosa using 99mTc pertechnetate: spectrum of scintgraphic findings. Br J Radiol 2005;78:714–20.
17. Jewett TC, Duscynski DO, Allen JE. The visualisation of Meckel's diverticulum with Tc-99m pertechnetate. Surgery 1970;68:567–70.
18. Treves S, Grand RJ, Eraklsi AJ. Pentagastrin stimulation of 99mTc uptake by ectopic gastric mucosa in a Meckel's diverticulum. Radiology 1978;128:711–2.
19. Diamond RH, Rothstein RD, Alavi A. The role of simetidine enhanced 99mTc pertechnetate imaging for visualising Meckels diverticulum. J Nucl Med 1991;16:1422–4.
20. Sfakianakis GN, Anderson GF, King DR, Boles ET. The effect of gastrointestinal hormones on the pertechnetate imaging of ectopic gastric mucosa in experimental Meckel's diverticulum. J Nucl Med 1981;22:678–83.
21. Chaudhuri TK, Chaudhuri TK, Christie JH. False positive Meckel's scan. Surgery 1972;71:313.
22. Fink-Bennett D. The uterine blush: a potential false-positive in Meckel's scan interpretation. Clin Nucl Med 1982;7:444.
23. Berquist TH, Nolan NG, Stephens DH, Carlson HC. Specificity of 99mTc pertechnetate in scintigraphic diagnosis of Meckel's diverticulum: review of 100 cases. J Nucl Med 1976;17:465–9.
24. Connoly L, Treves T, Bozorgi F, O'Connor SC. Meckel's diverticulum: demonstration of heterotropic gastric mucosa with Tc-99m pertechnetate SPECT. J Nucl Med 1998;39: 1458–60.
25. Ford PV, Bartold SP, Fink-Bennett D, Lull RJ, Maurer AH, Seabold JE. Society of Nuclear Medicine Procedure Guidelines for Gastrointestinal Bleeding and Meckel's Diverticulum Scintigraphy Society of Nuclear Medicine Procedure Guidelines Manual. June 2002.