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CASE REPORT

Utility of SPECT/CT with Meckel's scintigraphy

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Abstract Meckel's diverticulum is a relatively common source of gastrointestinal tract morbidity in children. Individuals may present with symptoms of lower gastrointestinal tract bleeding, bowel obstruction or diverticulitis. Technetium-99 m pertechnetate scintigraphy is used to demonstrate those Meckel's diverticula that contain heterotopic gastric mucosa. We present a case of an adolescent male patient with rectal bleeding and suspected Meckel's diverticulum where the use of SPECT/CT fusion imaging provided valuable diagnostic information and prevented a false-negative study.

Keywords Meckel's diverticulum · Tc-99 m pertechnetate scintigraphy · SPECT/CT

Introduction

Meckel's diverticulum is a common source of gastrointestinal tract morbidity in children, with a 0.5–3% prevalence based on autopsy series, making it the most common congenital anomaly of the small intestine [1, 2]. These structures represent incomplete obliteration of the omphalomesenteric (vitelline) duct that connects the embryonic midgut to the yolk sac. Meckel's diverticula arise from the antimesenteric surface of the ileum and are almost always located within 100 cm of the ileocecal valve.

Only a minority of individuals (between 4 and 25%) with a Meckel's diverticulum will develop symptoms, typically presenting at less than 10 years of age [1, 2]. Symptomatic Meckel's diverticula most commonly cause lower gastrointestinal tract hemorrhage. Occasionally, individuals may present with signs and symptoms of small bowel obstruction or diverticulitis. Gastrointestinal bleeding is the usual indication to perform Tc-99 m pertechnetate scintigraphy (Meckel's scan) in detecting the presence of heterotopic gastric mucosa, which causes mucosal ulceration.

Hybrid single photon emission computed tomography/computed tomography (SPECT/CT) gamma camera is a relatively novel technology that allows direct simultaneous fusion of functional and anatomic information. Their utility in a range of diagnostic nuclear medicine studies is being increasingly reported in literature, although application to Meckel's scintigraphy has not been well described to date. We present a case of an adolescent male patient in whom SPECT/CT fusion imaging provided important diagnostic information and prevented a false-negative imaging study. Readers are encouraged to form an opinion based on the planar images in this case before viewing the corresponding SPECT/CT images.

Case

A 17-year-old male patient presented to an outside hospital emergency department with a 4-day history of painless black stools and multiple episodes of passing bright red blood per

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rectum. Initial serum hemoglobin concentration was normal (14.9 gm/dL), and the patient was discharged home and scheduled for gastroenterology follow-up. Following three more days of similar symptoms, a repeat serum hemoglobin concentration measurement revealed new-onset anemia (9.2 gm/dL). The patient had no additional relevant past medical history. Physical examination was unremarkable.

The patient was subsequently admitted to our institution for further diagnostic evaluation. Esophagogastroduodenoscopy was unremarkable and completely visualized the upper gastrointestinal tract to the third portion of the duodenum.

As the patient continued to experience painless gastrointestinal tract bleeding, Tc-99 m pertechnetate scintigraphy was performed (Fig. 1). Pharmacological pretreatment with histamine (H2) receptor antagonists (e.g., cimetidine) prior to Meckel's scanning was not used for our patient. No focal uptake was identified within the abdomen on planar images to suggest the presence of a Meckel's diverticulum. However, due to high clinical suspicion, SPECT/CT fusion imaging was performed (Symbia T6, Siemens Medical Solutions, Malvern, PA, USA) (Fig. 2). Focal radiotracer accumulation within the right hemiabdomen localized to an apparent blind-ending loop of bowel on SPECT/CT images and was considered highly suspicious for the presence of a Meckel's diverticulum.

The patient had laparoscopic surgery the following day, confirming the presence of a Meckel's diverticulum. Histopathology examination of the resected specimen described a "Meckel's diverticulum with gastric mucosa" (Fig. 3).

Discussion

Technetium-99 m pertechnetate scintigraphy is commonly used in the evaluation of children and young adults with unexplained gastrointestinal tract bleeding. A large study of 917 patients by Sfakianakis and Conway [3] demonstrated a diagnostic sensitivity of 85%, specificity of 95%, and overall accuracy of 90% for the detection of heterotopic gastric mucosa by Meckel's scintigraphy. A more recent investigation by Swaniker et al. [4] included 43 patients with lower gastrointestinal tract bleeding and a serum hemoglobin concentration less than 11 g/dL. Meckel's scan sensitivity was 60%, specificity was 96%, positive predictive value was 100%, and negative predictive value was only 74%. As their study contained eight false-negative Meckel's scans (all of which contained heterotopic gastric mucosa at histopathology), the authors suggested that exploratory laparoscopy may be indicated instead of scintigraphy in certain clinical settings.

When there is high clinical suspicion for Meckel's diverticulum and negative or equivocal planar imaging, the acquisition of SPECT images may be of additional diagnostic utility, providing improved contrast resolution without additional radiation exposure to the patient. This is illustrated by our case, in which performance of SPECT/CT fusion imaging prevented a false-negative scintigraphic examination. A similar case of a negative planar and positive SPECT Meckel's scan was reported by Connolly et al. [5]. A positive SPECT/CT Meckel's scan has been documented in the literature; although planar imaging was frankly positive in that case [6].

The ability of SPECT/CT imaging to allow precise efficient localization of activity at an abnormal anatomic structure led to correct scan interpretation and improved reader confidence in the diagnosis. Any risks associated with a delayed diagnosis were minimized and unnecessary additional patient imaging was avoided (such as a subsequent small bowel follow-through examination or CT enterography that would result in even greater radiation exposure to the patient). A positive SPECT/CT study could potentially assist in surgical planning for Meckel's diverticulum.

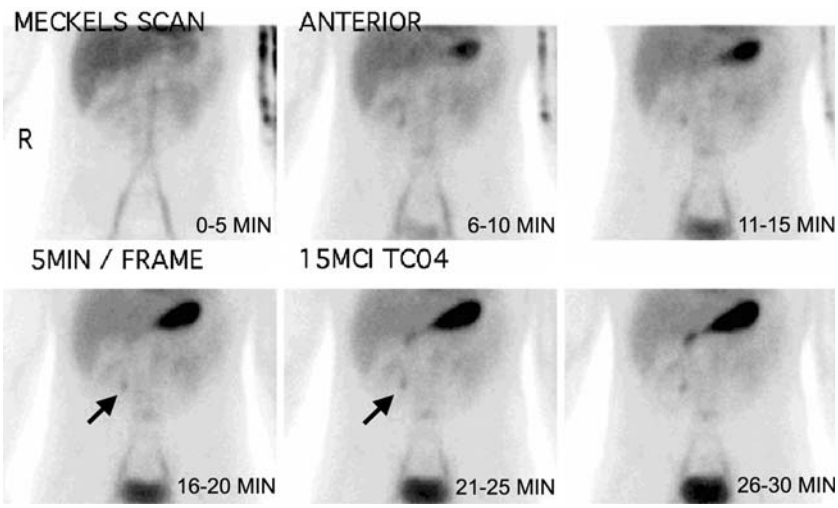

Fig. 1 Sequential anterior planar images acquired over 30 min (5 min/frame) following 550 MBq intravenous Tc-99 m pertechnetate demonstrate no focal abdominal uptake to suggest the presence of a Meckel's diverticulum. A subtle focus of activity within the right hemiabdomen (*arrows*) was thought to most likely reside within the urinary tract rather than within the Meckel's diverticulum

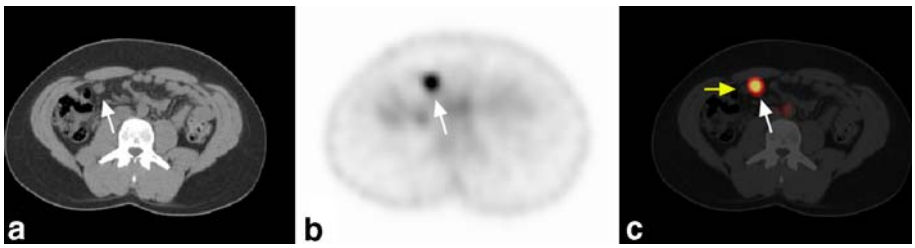

Fig. 2 **a** Axial CT image demonstrated a blind-ending tubular structure in the right hemiabdomen (*arrow*). **b** Axial SPECT image obtained immediately following the acquisition of planar images demonstrated abnormal focal radiotracer activity in the right hemiabdomen (*arrow*). This did not seem to correspond to the planar activity that was likely within the urinary tract. **c** Axial fused SPECT/CT images verified that the focus of right hemiabdomen uptake localized anatomically to the blind-ending tubular structure (*white arrow*), consistent with a Meckel's diverticulum. There was slight misregistration on the axial fused image (*yellow arrow*) likely due to intestinal peristalsis

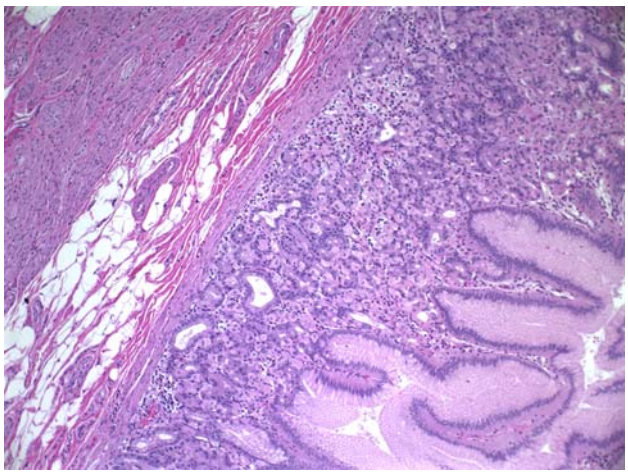

Fig. 3 The surgical specimen consisted of a 3.6-cm segment of the terminal ileum, containing an outpocketing measuring 3.2 × 1.3 × 1.3 cm. The majority of this diverticulum was lined with heterotopic gastric mucosa. Photomicrograph (high-power ×100, hematoxylin-eosin stain) demonstrates surface foveolar cells and oxyntic glands composed of eosinophilic parietal cells adjacent to basophilic chief cells

The role of SPECT/CT fusion imaging in children has not clearly been established, however, and it should be used in a judicious manner. This is because there is a small amount of added radiation exposure to the child from the CT portion of the examination in addition to the radiation exposure from the Meckel's scan. A review by Gelfand et al. [7] concluded that SPECT/CT dose reduction in children can be successfully achieved by modifying CT imaging parameters. For SPECT/CT at our institution, we reduce the mA to approximately one-third of that of a conventional "diagnostic" CT examination. Consequently, we are able to achieve a 66% dose reduction compared to conventional "diagnostic" CT imaging. In addition, the craniocaudal coverage of the CT portion of the study may be limited to the region of interest resulting in further dose reduction. The risks versus benefits should be discussed with the referring physician prior to performing SPECT/CT fusion imaging in children to confirm the clinical necessity of the imaging examination.

Traditional planar images may be diagnostic for Meckel's diverticulum in the appropriate clinical setting. In the setting of equivocal or negative planar imaging and high clinical suspicion for Meckel's diverticulum, additional SPECT imaging should be obtained. SPECT/CT fusion imaging with Meckel's scans could potentially improve diagnostic accuracy by increasing sensitivity without compromising specificity. Further studies of the utility of SPECT/CT for Meckel's scintigraphy are warranted.

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