Radionuclide Diagnosis of Meckel's Diverticulum

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Abstract. Meckel's diverticulum can be detected with a high degree of accuracy by radionuclide scintigraphy using technetium-99m pertechnetate. The technique is without risk and should precede roentgenographic studies when the diagnosis is suspected. The method is described and the causes for false positive and false negative examinations are discussed. False negatives are rare and false positives are usually secondary to other surgical entities. Overall accuracy is 85 to 90%.

Key words: Meckel's diverticulum – Abdominal scintigraphy – Technetium-99m pertechnetate – Ectopic gastric mucosa.

Meckel's diverticulum is the most common gastrointestinal malformation in man, occurring in approximately 1–3% of the population. About 25% of these individuals will develop complications, and this may occur at any age. Complications that require surgery usually are detected in children and young adults.

The anomaly is the vestigial remnant of the omphalomesenteric duct and is usually found along the antimesenteric border of the distal ileum. Although only a small percentage of Meckel's diverticula contain gastric mucosa, these lead to complications such as peptic ulceration and hemorrhage.

The concept of detecting ectopic gastric mucosa with radionuclide imaging was first proposed by Harden et al. in 1967 [1]. Their report on the value of stomach scanning with intravenous $^{99m}$Tc pertechnetate mentions the possibility of localizing ectopic gastric mucosa such as within a Meckel's diverticulum. The first clinical application of this postulate was reported by Jewett et al. [2] in 1970. Although the complications of Meckel's diverticulum can be detected roentgenographically [3], routine roentgenographic studies are usually considered of little value [4]. Radionuclide imaging is considered to have an accuracy of between 80% and 90% and thus was readily adopted as a means for evaluating the diverticulum's presence.

Methods and Materials

The ability with which radionuclides detect Meckel's diverticulum is dependent on technique. Earlier studies utilizing rectilinear scans and delayed imaging were fraught with false positive interpretations due to migration of secreted $^{99m}$Tc pertechnetate from the stomach into the distal bowel. The following factors have been found to enhance the detectability of the Meckel's diverticulum.

1. No Preparation. If at all possible, one should perform radionuclide imaging before barium sulfate studies and/or proctoscopy of the bowel. Irritation of the mucosa may stimulate radionuclide localization causing false positive interpretation. Attenuation of photons by barium sulfate potentially could mask localization of the radionuclide within the diverticulum. Proctoscopic examination particularly should be avoided prior to radionuclide imaging.

2. No Potassium Perchlorate. Potassium perchlorate is known to inhibit localization of radionuclide within the ectopic gastric mucosa [5]; therefore the patient should not receive this medication prior to imaging. The potassium perchlorate may be administered following the radionuclide study to decrease the radioactive pertechnetate ion within the thyroid gland.

3. Void Prior to and During Examination. The Meckel's diverticulum may be located in proximity to the urinary bladder. Since a significant amount of $^{99m}$Tc pertechnetate is excreted via the kidneys into the bladder, the potential exists for masking a small localization adjacent to the bladder. Persistence of activity in a given locale mitigates against the activity being within the ureter or in a diverticulum of the bladder.

4. Nasogastric Intubation. Earlier techniques recommended the use of nasogastric intubation with suction to decrease transit of secreted radionuclide from the stomach into the distal bowel. This factor was common with the use of rectilinear scans and delayed imaging. Newer techniques using the gamma camera and studies limited to 1 hour are less susceptible to this occurrence. Occasionally, and particularly in the presence of generalized bowel inflammation,

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there is a rapid localization of radionuclide throughout the bowel resulting in a difficult interpretation. Nasogastric suction does not reduce this phenomenon. An irritable bowel also has a more rapid transit time, often as short as 10 minutes, which contributes to the difficulty in interpretation. If the clinical condition permits, one may repeat the examination on the following day with nasogastric suction. In most instances, it is unnecessary to perform the study with nasogastric intubation.

5. Dose. The usual dose is 100 µCi of ⁹⁹ᵐTc pertechnetate per pound of body weight. This dose may be increased in the uncooperative child. This is the same as used for brain imaging and thus is an acceptable risk when considering the benefit and the increased efficacy compared to other diagnostic modalities. The study is acceptable to the Nuclear Regulatory Commission and Food and Drug Administration guidelines and thus does not require a special consent.

6. Imaging Sequence. Anterior gamma camera images are obtained every 5–10 minutes for 1 hour duration. Oblique, erect, or lateral views are obtained as required. In general, one expects the Meckel’s diverticulum to appear simultaneously with the gastric mucosa. This usually is between 10 and 20 minutes. Uncommonly there is a delayed appearance but this rarely occurs after the 1 hour interval.

True Positive Parameters

A number of factors enhance the accuracy of imaging interpretation.

1. Location. The Meckel’s diverticulum generally resides in the right lower quadrant of the abdomen but may be found in any location and indeed may move considerably during the study. Positive studies have been reported with the diverticulum in the left lower quadrant or in the right upper quadrant behind the liver. In general, one expects the diverticulum to be intra-abdominal and thus it is easily differentiated from activity within the retroperitoneal genitourinary tract. A lateral abdomen projection will delineate the intra-abdominal localization since the retroperitoneal structures are posterior to the anterior margin of the lumbar spine (Fig. 1).

One expects to find the Meckel’s diverticulum separate from the radionuclide activity in the proximal bowel. Continuity of activity within other bowel loops should alert one to the possibility of migration of the secreted activity within the lumen and/or other processes such as regional enteritis.

2. Sequence. In general, one expects the appearance of ectopic gastric mucosa activity simultaneously with the stomach. However, the amount of gastric mucosa present within the diverticulum is much less than that within the stomach, and therefore the intensity of localization within the stomach is greater in most instances. The ectopic gastric mucosa most often is visualized initially between 10 and 20 minutes after injection of the radionuclide. Of importance, one would expect persistence of the localization in multiple images during the study. The potential exists for

Fig. 1. The localization of ⁹⁹ᵐTc pertechnetate in a Meckel’s diverticulum (arrow) is in the mid-abdomen above the bladder (B) in this lateral projection, thus differentiating it from retroperitoneal structures such as the genito-urinary tract.