



Early Detection of Meckel's Diverticulum and Gastrointestinal Bleeding in Pediatric Patients Using Radionuclide Scintigraphy

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DOI: 10.31080/ASMS.2025.09.2015

Received: December 12, 2024

Published: January 21, 2025

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Abstract

Purpose: This study aims to evaluate the role of technetium-99 (99mTc) scintigraphy of the gastrointestinal tract in the diagnosis or detection of ectopic mucosa of Meckel's diverticulum, particularly involving the mid and lower gastrointestinal (GI) tract, and of 99mTc-RBC labeling of red blood cells in determining the status of active or intermittent-passive bleeding.

Methodology: The detection and localization of symptomatic Meckel's diverticulum is based on the accumulation of technetium-99m pertechnetate (99mTc) in the gastric mucosa, which is transported in a manner similar to that of halide anions. Scanning with technetium-99m-labeled red blood cells (99mTc-RBC) shows an abnormal focus of increased activity that increases in intensity over time.

The analyses also included selected cases where pharmacological interventions such as premedication with proton pump inhibitors such as omeprazole were used in children to increase diagnostic specificity.

Results: A retrospective analysis was performed on 42 referred cases, involving children aged 6.5 months to 4 years. Of these, 32 children (76.19%) presented with passive bleeding, while 10 children (23.80%) presented with active bleeding.

In the group of 32 children with passive bleeding, 7 children (21.87%) resulted with ectopic mucosa. Four children had been previously treated with proton pump inhibitors, of which three were identified as having the presence of ectopic mucosa.

Of the 10 children with active bleeding, who were evaluated with pyrophosphate, active bleeding was confirmed in 6 of them. In four cases, this was related to the use of Ibuprofen, while in two children small bowel bleeding was detected.

Discussion: The 99mTc-pertechnetate method alone offers high sensitivity for detecting the location of inactive bleeding from the ectopic mucosa of Meckel's diverticulum, when combined with proton pump inhibitors significantly increases the specificity of the diagnosis, while the method with in vivo pyrophosphate-labeled erythrocytes offers accuracy for active bleeding in the gastrointestinal tract.

Keywords: Scintigraphy of Gastrointestinal Bleeding; Meckel's Diverticulum; 99mTc-Pertechnetate; 99mTc ER; Labeled with Pyrophosphate

Introduction

Gastrointestinal bleeding scan (GIBS) is a noninvasive radionuclide diagnostic study to evaluate patients with ectopic mucosal bleeding or suspected bleeding involving the mid and lower gastrointestinal tract.

Clinical indications for GIBS include black or tarry stools, anemia, and ischemic bowel. The GIBS procedure is performed in accordance with the Society of Nuclear Medicine and Molecular Imaging (SNMMI) standard of care and EANM practice guidelines [1]. By Mary Beth Farrell and Joyce Zimmerman; Journal of Nuclear Medicine Technology September 2020, 48 [3]. 210-213; DOI: <https://doi.org/10.2967/jnmt.120.251918> [2,5].

Meckel's diverticulum is a congenital malformation of the lower ileum. It is the most common congenital anomaly of the gastrointestinal tract, occurring in 1% to 3% of the population. The condition is named after the German anatomist Johann Friedrich Meckel, who first described the condition in 1809, who described it as a remnant of the omphalomesenteric duct. In 1598 Fabricius Hildanmas also described the anomaly, as did Lavater in 1671; however, Meckel is credited with being the first to recognize its embryological origin [3].

Meckel's diverticulum is the most common cause of gastrointestinal bleeding in children and requires surgical correction. Meckel's diverticula can also cause local irritation without perforation. Symptoms of Meckel's diverticulum include gastrointestinal bleeding, cramping, tenderness near the umbilicus, painful bowel obstruction, bloating, diarrhea, constipation, vomiting, and diverticulitis [4].

Imaging procedure

The recommended dose for imaging Meckel's diverticulum by the 2012 North American Consensus Guidelines for the

Administration of Pediatric Radiopharmaceuticals is 1.85 MBq/kg (0.05 mCi/kg) of 99mTc-pertechnetate. The minimum dose administered is 9.25 MBq (0.25 mCi). The dose for adults is 300 MBq (8 mCi), with a range of 300 to 400 MBq (8-12 mCi) of 99mTc-pertechnetate intravenously [6].

A suspected visible gastrointestinal (GI) bleed, especially involving the mid and lower gastrointestinal (GI) tract, is performed by labeling red blood cells with 99mTc-RBC and helps determine the bleeding status (active or intermittent-passive), its exact localization, and its quantification [7].

Recommended radionuclide dose for adults: 15-30 mCi, Children [8]: 2.16-21.2 mCi (per EANM pediatric dosing card).

Methods

This retrospective study analyzed data from 42 pediatric cases referred for gastrointestinal bleeding scintigraphy. Patients were categorized based on age, clinical presentation, and scintigraphic findings (children aged 6.5 months to 4 years). The radiotracer used was 99mTc-pertechnetate, which was administered intravenously at a dose of 18.5 MBq per kilogram of body weight. Images were recorded with a Siemens dual-head gamma camera for one hour, and dynamic flow images were acquired at 1 second per frame for 1 minute for at least 60 minutes. Flow images help to identify a focus of blood clot that could be confused with ectopic gastric mucosa. If dynamic images are normal, images for more than 60 minutes are not useful because activity will begin to shift from the stomach to the intestine.

Meckel's diverticulum usually appears as a focus of increased tracer activity in the right lower quadrant within 5 to 10 minutes after injection (Figure 1).

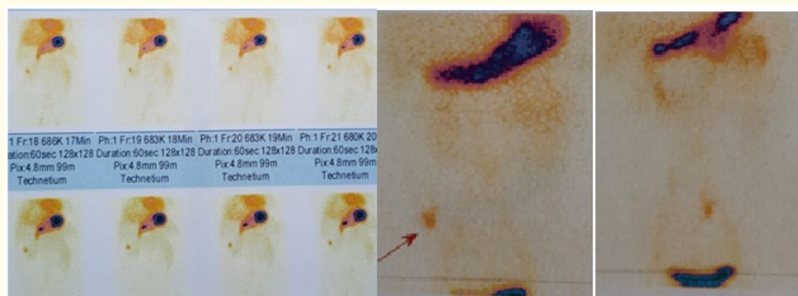


Figure 1: Dynamic sequences with a focal focus over the right lower quadrant Within 5 or 10 minutes after injection and in the following minute's focal foci intensifying and static spots with focal area of activity in the right lower quadrant. Ectopic gastric mucosa is visible as a focal, localized area of uptake that occurs concurrently with activity in normal gastric mucosa. The intensity of activity may appear to fluctuate due to intestinal secretions, increased intestinal motility that flushes out the pertechnetate, or hemorrhage.

Gastrointestinal bleeding scanning uses erythrocytes labeled “in vivo” with ^{99m}Tc -RBCs. numerous studies have shown that technetium-labeled erythrocytes (^{99m}Tc -RBCs) are superior

because of their long intravascular half-life, which allows for longer imaging times. (9,105) and has been used in patients with active bleeding in whom no source has been identified (Figure 2).

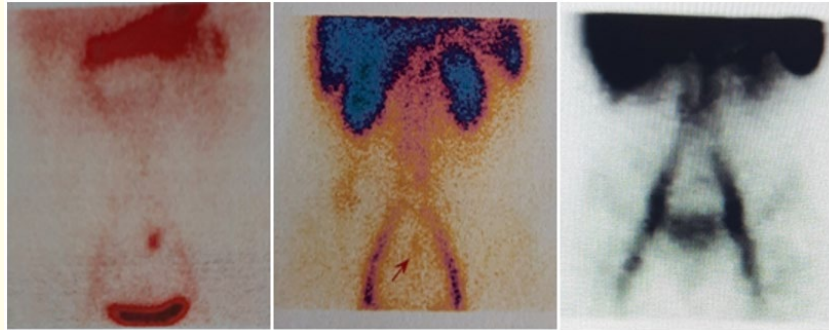


Figure 2: Technetium-99m-labeled red blood cell (^{99m}Tc -RBC) scan shows an abnormal focus of increased activity in the left lower middle quadrant, consistent with gastrointestinal bleeding. This activity is seen to increase in intensity over time.

Results

A retrospective analysis was performed on 42 referred cases.

Baseline data

- Total number of cases: 42 children
- Passive bleeding: 32 cases (76.19%)

Of these, 7 cases (21.87%) had ectopic mucosa.

4 children were treated with proton pump inhibitors, and of these, 3 had ectopic mucosa.

Active bleeding: 10 cases (23.80%).

Of these, 6 cases were identified with active bleeding using pyrophosphate.

Of these 6, 4 cases were caused by the use of Ibuprofen, while 2 cases had bleeding in the small intestine.

Control and calculation of percentages

Of the children with passive bleeding (32):

$7/32 = 21.87\%$ were diagnosed with ectopic mucosa.

$4/32 = 12.5\%$ were treated with proton pump inhibitors.

$3/4 = 75\%$ of those treated with proton pump inhibitors had ectopic mucosa.

Of the children with active bleeding (10):

$6/10 = 60\%$ were identified as having active pyrophosphate bleeding.

$4/6 = 66.66\%$ of these had Ibuprofen bleeding.

$2/10 = 20\%$ had small bowel bleeding.

These results are based on data collected from retrospective analyses conducted by the authors.

Discussion

Many symptoms can mimic various abdominal disease states, and Meckel's diverticulum can often be difficult to diagnose. The clinical indication for Meckel's diverticulum scanning is unexplained gastrointestinal bleeding, especially in young children. Meckel's diverticulum scanning is usually performed if the patient has passive bleeding and should not be performed if the patient has active bleeding. If the patient has active bleeding, a gastrointestinal bleeding scan with radionuclide-labeled red blood cells is indicated. We used ^{99m}Tc -labeled pyrophosphate according to protocol.

Some medications may positively affect the scan results, such as histamine H2 blockers and glucagon administration before the test, which improve the sensitivity of the study. Proton pump inhibitors such as omeprazole and lansoprazole may also be useful and are often used in children.

Pretreatment with glucagon helps relax smooth muscle and reduce peristalsis of the gastrointestinal tract. Slowing the passage of secreted pertechnetate helps in detection. Note: Glucagon should not be given to patients with diabetes [10].

Acute GI bleeding may require immediate surgical intervention, therefore the role of technetium-99 (99m-Tc) radionuclide scanning of the gastrointestinal tract and Tc-99m RBC scanning in the diagnosis or detection of ectopic mucosa of Meckel's diverticulum, or lower gastrointestinal bleeding, may be alternative first-line procedures, complementary with advantages to detect the suspected cause and location in cases where endoscopy cannot show results and are considered as important imaging tools for localization of GI bleeding lesions.

Ibuprofen is one of the most commonly used NSAIDs in pediatric patients due to its anti-inflammatory and antipyretic properties. Ibuprofen may be a risk factor for gastrointestinal bleeding, although the literature describes several cases of gastrointestinal bleeding after taking small doses of ibuprofen at appropriate intervals. Berezin, *et al.* (2007) described a case series of four children, in which three of them received one dose of ibuprofen and one received two doses, and although the dose was appropriate, all of them developed hematemesis due to gastric antral ulcer [12]. Vaquero Sosa, *et al.* (2013) [13] reported on a study involving nine patients aged 21 months to five years who presented with upper gastrointestinal bleeding after two to four doses of ibuprofen.

Conclusion

Emergency cases often lead to a complex situation as an unexpected event or situation requiring immediate action. Therefore, a rapid diagnosis and choice of therapeutic approach is mandatory.

Although nuclear medicine studies are considered to be more sensitive than angiography [6,11], in emergency settings.

Bibliography

1. Spottswood SE., *et al.* "SNMMI and EANM practice guideline for Meckel diverticulum scintigraphy 2.0". *Journal of Nuclear Medicine Technology* 42.3(2014):163-169.
2. Kwak J., *et al.* "Utility of Meckel's scan: retrospective review of 368 cases". *Journal of Nuclear Medicine* 54.2(2014):535.
3. Nga Mary Beth Farrell and Joyce Zimmerman. "Meckel's Diverticulum Imaging". *Journal of Nuclear Medicine Technology* 48.3(2020):210-213.
4. Reprinted from Bolus N., *et al.* Abdominal Imaging 2017: Quality, Safety, and Dose Optimization. Reston, VA: Society of Nuclear Medicine and Molecular Imaging (2017):76-83.
5. Holzheimer R., *et al.* "Meckel's diverticulum". In: Holzheimer R, Mannick J, eds. Surgical Treatment: Evidence-Based and Problem-Oriented. Munich: Zuckschwerdt (2001).
6. SNMMI Procedure Standard-EANM Practice Guideline Gastrointestinal Bleeding Scintigraphy 2.0.
7. Dam HQ., *et al.* "The SNMMI procedure standard/EANM practice guideline for gastrointestinal bleeding scintigraphy 2.0". *Journal of Nuclear Medicine Technology* (2014).
8. Lassmann M and Treves ST. "Pediatric Radiopharmaceutical Administration: harmonization of the 2007 EANM Paediatric Dosage Card (Version 1.5.2008) and the 2010 North American Consensus guideline". *European Journal of Nuclear Medicine and Molecular Imaging* (2014).
9. Grady E. "Gastrointestinal Bleeding Scintigraphy in the Early 21st Century". *Journal of Nuclear Medicine: Official Publication, Society of Nuclear Medicine* (2016).
10. Heyman S. "Meckel's diverticulum: possible detection by combining pentagastrin with histamine H2 receptor blocker". *Journal of Nuclear Medicine* 35.10(1994):1656-1658.
11. Kuhle WG and Sheiman RG. "Detection of active colonic hemorrhage with use of helical CT: findings in a swine model". *Radiology* 228(2003): 743-752.
12. Berezin SH., *et al.* "Gastrointestinal bleeding in children following ingestion of low-dose ibuprofen". *Journal of Pediatric Gastroenterology and Nutrition* 44(2007):506-508.
13. Vaquero Sosa E., *et al.* "Gastrointestinal bleeding following ingestion of low-dose ibuprofen". *Annals of Pediatrics (Barc)* 78(2013):51-53.