

## Presentation and Management of Meckel's Diverticulum in Children

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**Received:** July 10, 2019; **Published:** July 19, 2019

### Abstract

**Introduction:** Meckel's diverticulum is considered to be the most common congenital defect of the gastrointestinal tract, that occurs in about two percent of the overall general population. The German physician and scientist Johann Friedrich Meckel was the first to describe that Meckel's diverticulum is a result of from the presence of an incomplete atrophy of the omphalomesenteric duct (also known as the vitelline duct). throughout early life of the fetus, the primitive midgut normally communicates with the yolk sac through the vitelline duct (omphalomesenteric duct). Meckel's diverticulum then occurs in cases where the vitelline duct does not succeed in completely regressing as normal. On the other hand, Meckel's diverticulum is not known to have associations with other important congenital malformations and defects.

Meckel's diverticulum is generally present at the anti-mesenteric side wall of the distal ileum, in contrast to alimentary duplications and most other known bowel diverticula. Meckel's diverticulum might retain a patent opening through the umbilicus, might be joined to the umbilicus with a fibrous cord, or it might stay as a freely movable blind pouch of various dimensions.

**Aim of Work:** In this review, we will discuss meckel's diverticulum.

**Methodology:** We did a systematic search for overview of Meckel's diverticulum using PubMed search engine (<http://www.ncbi.nlm.nih.gov/>) and Google Scholar search engine (<https://scholar.google.com>). All relevant studies were retrieved and discussed. We only included full articles.

**Conclusions:** Meckel's diverticulum is considered to be the most common congenital malformation of the gastrointestinal tract, that occurs in up to two percent of the overall general population. Meckel's diverticulum is typically asymptomatic and is usually found incidentally. However, the lifetime risk of complications can be as high as forty percent. In this essay, we described the clinical and imaging findings in 12 cases of Meckel's diverticula with complications over a 5-year period, which were confirmed pathologically. The major complications of Meckel's diverticulum include gastrointestinal bleeding, bowel obstruction, perforation and inflammation. Small bowel follow-through (SBFT), computed tomography (CT) including CT enterography and RI scintigraphy can be used to show typical imaging features of Meckel's diverticulum and its complications. Knowledge of the clinical and radiologic findings of Meckel's diverticulum can aid in the early and accurate diagnosis of this anomaly and its complications.

**Keywords:** Diverticulum; Gastrointestinal Bleeding, Intestinal Perforation; Meckel Diverticulum

### Introduction

Meckel's diverticulum is considered to be the most common congenital defect of the gastrointestinal tract, that occurs in about two percent of the overall general population. The German physician and scientist Johann Friedrich Meckel was the first to describe that Meckel's diverticulum is a result of from the presence of an incomplete atrophy of the omphalomesenteric duct (also known as the vitelline duct). Throughout early life of the fetus, the primitive midgut normally communicates with the yolk sac through the vitelline duct (omphalomesenteric duct). Meckel's diverticulum then occurs in cases where the vitelline duct does not succeed in completely regressing as normal. On the other hand, Meckel's diverticulum is not known to have associations with other important congenital malformations and defects.

Meckel's diverticulum is generally present at the anti-mesenteric side wall of the distal ileum, in contrast to alimentary duplications and most other known bowel diverticula. Meckel's diverticulum might retain a patent opening through the umbilicus, might be joined to the umbilicus with a fibrous cord, or it might stay as a freely movable blind pouch of various dimensions.

Due to the fact that most patients who have Meckel's diverticulum without complications do not generally express clinical manifestations, Meckel's diverticulum could stay undiagnosed in many cases, with having a lifetime risk of developing any complications to range widely from four to forty percent of cases. Meckel's diverticulum is usually diagnosed incidentally while doing an operation or performing radiologic evaluation for other medical conditions or is often discovered during an autopsy. About fifty percent of all children who have Meckel's diverticulum present with clinical manifestations that include rectal bleeding or intussusception before two years of age. however, adult patients who have Meckel's diverticulum tend to present with signs and symptoms of inflammation and/or obstructive disease rather than developing bleeding.

In this review, we will discuss the most recent evidence regarding presentation and management of Meckel's diverticulum.

### Methodology

We did a systematic search for overview of Meckel's diverticulum using PubMed search engine (<http://www.ncbi.nlm.nih.gov/>) and Google Scholar search engine (<https://scholar.google.com>). All relevant studies were retrieved and discussed. We only included full articles.

The terms used in the search were: diverticulum; gastrointestinal bleeding, intestinal perforation; Meckel diverticulum

### Imaging diagnosis of Meckel's diverticulum

Several imaging modalities have been used to make a diagnosis of Meckel's diverticulum. Plain x-ray radiographs are known to have limited benefits and often fail to reveal but might demonstrate the underlying presence of enteroliths or bowel obstruction. Conventional barium studies, like small bowel follow-through (SBFT), on the other hand, have been replaced by other more advanced imaging modalities that are for assessment of Meckel's diverticulum patients who present with acute and/or severe clinical manifestations. Following the application of barium, Meckel's diverticulum starts to look like a blind-ended pouch that originates from the anti-mesenteric border of the distal ileum. The discovery of filling defects within Meckel's diverticulum could be a representative of the underlying presence of an ectopic gastric mucosa or tumor (neoplasm) [1].

Despite the fact that it is known to have a relatively limited value, the use of ultrasonography is routinely performed to evaluate children patients who present with right lower quadrant pain. Using high-resolution ultrasonography, Meckel's diverticulum often appears as a fluid-filled structure that is present within the right lower quadrant abdomen with classical gut characteristics, a blind-ending and thick-walled bowel loop, and a direct communication with the normal small bowel loop. Hyperechoic mucosa ('classical gut signature') is usually found, and enteroliths are detected as echogenic foci with posterior acoustic shadowing [2].

On CT imaging, Meckel's diverticulum is usually generally hard to distinguish from any other normal small bowel in uncomplicated patients. On the other hand, a fluid- or gas-filled blind-ending structure that is continuous with small bowel loops could be observed. CT imaging could also demonstrate the presence of enteroliths within Meckel's diverticulum, intussusception, diverticulitis and small bowel obstruction. CT imaging is generally superior to other imaging modalities while assessing the general complications of Meckel's diverticulum [3].

In most patients who have Meckel's diverticulum and who suffer from the development of chronic gastrointestinal bleeding, angiography could be used to reveal a remnant omphalomesenteric artery [4]. Radioisotope (RI) scintigraphy modality is generally used to detect the presence of bleeding, which often presents as the presence of an accumulation of isotope in the right lower quadrant in a positive scan [5]. On the other hand, it could only help in the diagnosis of cases where there is ectopic gastric mucosa as radioisotope is normally taken up by mucin-secreting cells of the normal gastric mucosa. As the age of patients with Meckel's diverticulum becomes older, the use of Radioisotope scintigraphy to detect bleeding in Meckel's diverticulum patients tends to have decreasing sensitivity.

### Imaging findings of complications of Meckel's diverticulum

The morbidity and clinical manifestations that are usually associated with Meckel's diverticulum are generally a result of complications that include chronic bleeding, perforation, volvulus, intussusception, enterolith formation, obstruction of the intestines and the development of neoplasms. Chronic bleeding is considered to be among the most common complications in patients who have symptomatic Meckel's diverticulum [6]. The development of a painless gastrointestinal bleeding is considered to be an important complication following Meckel's diverticulum and is a result of acid-secreting gastric or pancreatic mucosa within Meckel's diverticulum itself. The detection of heterotopic mucosa is essential in these cases. The length and base diameter of Meckel's diverticulum are usually well-recognized as risk factors that are strongly associated with the later development of complications. Among these predisposing factors, long- and narrow-based diverticula are generally thought to be more vulnerable to the later development of obstruction or inflammation. CT imaging or CT enterography, SBFT and RI scintigraphy are generally considered to be the most important imaging modalities that are used to make and confirm the diagnosis of Meckel's diverticulum and detect the presence of complications associated with the disease.

### Haemorrhage

Bleeding is considered to be the most common complication following Meckel's diverticulum specifically in the children and pediatric populations and is usually correlated with the development of peptic ulceration caused by the heterotopic or ectopic gastric mucosa within the diverticulum in most of the cases. These ectopic mucosae are typically detected in twenty to fifty-five percent of patients who have Meckel's diverticulum. It is estimated that about ninety nine percent of cases of Meckel's diverticula presents with hemorrhage caused by the contained gastric mucosa. CT imaging could be used to reveal the gastric mucosa within diverticula with well-enhanced nodular areas. A persistent omphalomesenteric artery could sometimes be found using techniques of conventional angiography in most Meckel's diverticulum patients who have gastrointestinal hemorrhage caused by the diverticulum. The use of Scintigraphy with  $^{99m}\text{Tc}$  pertechnetate helps for the detection of heterotopic or ectopic gastric mucosa, as the isotope is taken up by mucin-secreting cells of the gastric mucosa [7,8].

### Bowel obstruction

In patients who have Meckel's diverticulum, the second most common complication is known to be the development of intestinal obstruction. Intestinal obstruction typically develops in older children or adults with Meckel's diverticulum and classically manifests as the development of abdominal distension, bilious vomiting, constipation and abdominal pain. Intestinal obstruction associated with Meckel's diverticulum could be caused by the development of adhesion, intussusception, inverted diverticulum or diverticulitis, volvulus or internal hernia caused by the persistent attachment of Meckel's diverticulum to the umbilicus by the presence of an obliterated meso-diverticular band, and tumor. Multi-detector CT imaging is considered to be a sensitive technique that could be used for making a diagnosis of small bowel obstructions. The most common cause of intestinal obstruction is known to be ileocolic intussusception. In such cases, dilated proximal small bowel loops with an intraluminal mass are present in the ascending colon on CT imaging [9].

### Inflammation

Cases of acute Meckel's diverticulitis usually mimic cases of acute appendicitis, and manifest as the development of acute abdominal pain and fever. The mechanism that underlies the Meckel's diverticulitis inflammation at the diverticular orifice with the development of later narrowing that occurs because of the presence of an enterolith, fecalith, foreign body, parasite, neoplasm or fibrosis from recurrent peptic ulcer. CT imaging is considered to be a relatively sensitive imaging modality that is typically used for the diagnosis of Meckel's diverticulitis, which is represented by a variable-sized, blind-ending pouch with mural thickening and surrounding mesenteric infiltration.

### Perforation

Perforation is considered to be a rare complication that could develop in patients who have Meckel's diverticulum. Despite that it is relatively less common, perforation could lead to the development of serious problems. Perforation often develops secondary to an inflammation, a gangrene, a peptic ulceration, an ingested foreign body or an intestinal obstruction. The presence of intra-abdominal free air or localized abscess on CT imaging or plain x-ray radiograph could indicate the presence of perforation in the setting of Meckel's diverticulum. CT imaging is known to have a relatively higher diagnostic capability when compared to any other imaging modality for the detection of perforation.

### Enterolith formation

The formation of an enterolith in patients who have Meckel's diverticulum is considered to be a relatively rare complication, that is reported in as few as 3 to 10 percent of Meckel's diverticulum cases. Clinical manifestations of enterolith formation in patients who have Meckel's diverticulum include the presence of chronic and intermittent abdominal pain or gastrointestinal hemorrhage.<sup>8</sup> Enterolith formation in patients with Meckel's diverticulum is thought to result following stasis. Plain x-ray radiography could be used to reveal about fifty percent of enteroliths, on the other hand, CT imaging examination is considered to be superior to plain x-ray radiography for the detection of enteroliths. In addition, the use of non-enhanced CT imaging is considered to be a more valuable modality for the detection of enteroliths in Meckel's diverticulum when compared to the use of contrast-enhanced CT.

### Intussusception or inversion

In patients who have Meckel's diverticulum, the diverticulum could possibly invert or invaginate into the small bowel lumen. When invagination develops, the mesenteric fat that surrounds the Meckel's diverticulum is pulled into the center of the diverticulum and could progress to develop an intestinal obstruction or intussusceptions. These cases of Meckel's diverticulum could be potentially dangerous if they are not detected and could progress to develop bowel necrosis, perforation and/or sepsis. Both Intussusception and inversion can appear as a smooth marginated intraluminal mass or a pedunculated intraluminal polyp using SBFT. On CT imaging, an inverted Meckel's diverticulum classically appears as a central area of fat attenuation with surrounding soft tissue attenuation. If Meckel's diverticulum itself acts as the leading point of the ileocolic or ileoileal intussusceptions, it is typically seen as a target-shaped mass by edematous intussusciens and intussusceptum on CT imaging.

### Torsion

The development of Torsion and later necrosis of Meckel's diverticulum could simultaneously lead to the development of mechanical small bowel obstruction. It is considered to be one of the rarest complications in Meckel's diverticulum patients and might produce non-specific abdominal clinical manifestations that mimic a case of acute appendicitis. Torsion is generally a result of the axial twisting of Meckel's diverticulum around its narrow base that could potentially compromise the blood supply, leading to later gangrene [10].

### Neoplasm

Neoplasms that arise from Meckel's diverticulum are considered to be extremely rare. Carcinoid tumor is the usually most commonly developed neoplasm arising from a Meckel's diverticulum [6].

This classically manifests as single, small and asymptomatic neoplasms. Most of these neoplasms are accidentally found on a histopathological assessment of a resected diverticular specimen following performing a surgical resection. Other reported neoplasms include the development of leiomyomas, leiomyosarcomas, neuromas, lipomas, angiomas, carcinosarcomas and adenocarcinomas.

On CT imaging, these neoplasms can show non-specific imaging findings including sessile or lobulated masses or focal wall thickening with contrast enhancement. Malignant tumors could extend into the perilesional mesenteric fat or adjacent organs including the urinary bladder [11].

In conclusion, it is well-known that Meckel's diverticulum is the most common anomaly of the gastrointestinal tract. Clinical manifestations are typically associated with complications from Meckel's diverticulum rather than Meckel's diverticulum itself. Clinicians and practitioners all agree that symptomatic Meckel's diverticulum must be surgically removed. Blind-ending, fluid- or gas-filled structures

continuous with the small bowel can help in the diagnosis of Meckel's diverticulum. Meckel's diverticulum's major complications include the development of hemorrhage, intestinal obstruction, inflammation, perforation, stones or neoplasm [12].

As clinical and imaging findings can overlap with those of other acute inflammatory lesions, preoperative diagnosis of Meckel's diverticulum and its complications can be challenging in many cases. Therefore, Knowledge of these imaging findings and combining radiologic characteristics of Meckel's diverticulum with its clinical manifestations could significantly help in the early and accurate diagnosis of the diverticulum and its complications.

### Conclusions

Meckel's diverticulum is considered to be the most common congenital malformation of the gastrointestinal tract, that occurs in up to two percent of the overall general population. Meckel's diverticulum is typically asymptomatic and is usually found incidentally. However, the lifetime risk of complications can be as high as forty percent. In this essay, we described the clinical and imaging findings in 12 cases of Meckel's diverticula with complications over a 5-year period, which were confirmed pathologically. The major complications of Meckel's diverticulum include gastrointestinal bleeding, bowel obstruction, perforation and inflammation. Small bowel follow-through (SBFT), computed tomography (CT) including CT enterography and RI scintigraphy can be used to show typical imaging features of Meckel's diverticulum and its complications. Knowledge of the clinical and radiologic findings of Meckel's diverticulum can aid in the early and accurate diagnosis of this anomaly and its complications.

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**Volume 15 Issue 8 August 2019**

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