Complications of Meckel's diverticula in adults:
Radiographic pictorial review.

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Learning objectives

1. To discuss the complications of Meckel's diverticula in adults.

2. To review cases and illustrate complications of Meckel's diverticula in adults using different imaging modalities.
Background

Meckel's diverticulum is the most common congenital malformation of the gastrointestinal tract. It is a true diverticulum which arises from the antimesenteric surface of the mid-to-distal ileum that results from persistence of the omphalomesenteric (vitelline) duct. Its blood supply comes from the vitelline artery, an anomalous terminal branch of the superior mesenteric artery that crosses the ileum to the diverticulum. This anatomy is important to recognize on conventional angiography when investigating a potential gastrointestinal bleed in the right lower quadrant.

Meckel's diverticulitis is difficult to diagnose clinically since many of the symptoms may be mistaken for other acute right lower quadrant pain such as appendicitis, Crohn's disease, mesenteric adenitis, omental infarct and cecal diverticulitis.

The classic description for Meckel's diverticulum is summarized using the "rule of twos": it is present in 2% of the population with a 2:1 male to female ratio, found within two feet of the ileocecal valve, averages two inches in length, often symptomatic before two years of age, and finally, at least 2% of these patients develop complication in their lifetime [1].

Meckel's diverticulum is most often asymptomatic in adults and the incidence of symptomatic Meckel's decreases with age in the adult population. Consequently, they are less likely considered on the clinician's or radiologist's top differential diagnosis. Symptomatic Meckel's diverticula are non-specific and can present as bowel obstruction, diverticulitis, perforation, gastrointestinal bleeding, and rarely, a neoplasm [4].

Keypoints: Complications of Meckel's diverticulum in adults:

- Obstruction
- Diverticulitis +/- perforation
- Gastrointestinal bleeding
- Neoplasm.

Bowel obstruction secondary to a Meckel's diverticulum has multiple causes such as diverticulum or enterolith acting as a lead point resulting in intussusception, a mesodiverticular band (an embryologic remnant of the vitelline circulation) causes the small bowel to twist along its long axis resulting in a volvulus and finally, incarceration of a Meckel’s in an abdominal wall hernia (i.e. Littre's hernia) through the inguinal, femoral or umbilical region [2].
As with any bowel diverticulum they are susceptible to acute inflammation when the diverticulum opening is obstructed either with an enterolith, food particulates, bezoars or other foreign bodies resulting in bacterial overgrowth and subsequently diverticulitis with potential perforation [3,4]. Clinically, these are often mistaken for appendicitis.

Ectopic tissue is found in approximately 50% of Meckel's diverticula and of those the two most common are gastric (60-85%) and pancreatic (5-16%) tissues. It is believed that the highly acidic gastric acid causes mucosal ulceration and bleeding adjacent to or distal to the diverticulum [5]. The type of ectopic tissue present is important to understand when interpreting a Meckel's scan (Tc-99m pertechnetate). Other rarer common tissue origins include duodenal, colonic, duodenal and hepatic [6].

Neoplasms are very rare and only found in 3% of patients with Meckel's diverticulum complications. Most are benign such as lipomas, leiomyomas and angiomas. Carcinoids are the most common malignancies, followed by gastrointestinal stromal tumors (GIST), leiomyosarcomas and adenocarcinomas [7].

Meckel's diverticulum is often incidentally discovered during laparotomy or radiologic abdominal study for an unrelated pathology. The management for these are controversial as to whether or not prophylactic removal of the Meckel's has any benefits [8].
Findings and procedure details

The various cases in our pictorial review show the imaging findings associated with complications of Meckel's diverticula in adults using different diagnostic imaging modalities (e.g. plain film, barium study, computer tomography, nuclear medicine and angiography).

Case 1

History: 48 year old female with anemia and occasional blood per rectum for last 6 years. Unremarkable colonoscopy and upper GI endoscopy. (Fig. 1 & 2)

The filling defects seen on this patient's barium study were found to represent old blood clots from chronic low grade bleeding following surgical resection. Patient's anemia and GI bleeding resolved few months after diverticulectomy.

Barium study: Meckel's diverticulum is often difficult to identify on small bowel follow through depending on the size. They can be seen easier with enteroclysis due to maximal luminal distension which will demonstrate the classic blind ending diverticulum along the antimesenteric border of the ileum.

Case 2

History: 77 year old male with nausea, vomiting, diffuse abdominal pain and chronic renal failure. (Fig. 3)

Radiographs: Plain film findings are non-specific for Meckel's diverticulum. However, the most common complication of Meckel's in adults is small bowel obstruction which can be seen on plain films and occasionally enteroliths can also be seen (Fig. 3).

Approximately one-third of enteroliths are radiopaque. Enterolithiasis may occur in diverticulum because of stasis. The alkalinity of the distal small bowel favors precipitation of mineral salts [12]. Interestingly enough, this correlates to this patient's negative Meckel's scan because enteroliths occur most commonly in diverticula that do not contain ectopic gastric mucosa, because the alkaline environment favors the precipitation of calcium and other mineral.
**Case 3**

History: 46 year old female with intermittent lower gastrointestinal bleeding and unremarkable colonoscopy. (Fig. 4)

**Nuclear medicine**: Te-99m pertechnetate Meckel scan is the most widely used imaging test for a bleeding Meckel’s diverticulum. However, the scan is dependent on the uptake by heterotopic gastric mucosa and not all Meckel's diverticula contain gastric ectopic tissue.

False positive results may be seen in adults with inflammatory mucosa of any cause (i.e. inflammatory bowel disease), ectopic gastric tissue, urinary tract obstruction, ectopic kidney or slow pooling of blood (Fig. 4 black arrow). The most common false negative result is due to minimal or absence of gastric ectopic tissue.

In children, the scan has a sensitivity of 90%, specificity of 95% and accuracy of 90% but is much lower in adults with sensitivity of 62.5%, specificity of 9% and accuracy of 46% [9,10]. Accuracy of the scan can be improved with the use of pentagastrin, glucagon or cimetidine. Pentagastrin and glucagon increases gastric mucosal uptake and ceases peristalsis, respectively. Cimetidine inhibits intraluminal release of technetium [11].

**Case 4**

History: 41 year old male with acute right lower quadrant pain x 3 days. (Fig. 5)

**Computed tomography (CT)**: It is difficult to distinguish Meckel’s diverticulum from small bowel on CT in uncomplicated cases. It appears as a blind-ending fluid or gas filled sac along the distal ileum in the RLQ. However, contrast enhanced CT is very useful in patients with complicated Meckel's diverticulum. In acute inflammation of the diverticulum there is evidence of mural thickening and enhancement of this blind-ending sac with adjacent mesenteric stranding (Fig. 5) [2].

Other CT findings related to complicated Meckel's diverticulum include evidence of small bowel obstruction, possible intussusception with the diverticulum as the lead point, and occasionally enteroliths (Fig. 3B) [2].
CT enterography allows for better visualization of the small bowel wall and Meckel's diverticulum due to distension of the small bowel with large volumes of ingested neutral enteric contrast solution [13].

CT angiography may demonstrate IV contrast extravasation from the vitelline arteries in patients with active GI bleeding; however, the bleeding typically requires >0.5 mL/min in order to be appreciated [14].

**Case 5**

History: 20 year old male with painless rectal bleeding x 6 days requiring blood transfusion on this admission. Patient had a negative upper GI endoscopy and colonoscopy previously for GI bleeding. (Fig. 6)

**Angiography**: Visualization of a nonbranching artery from the ileal artery and a group of dilated tortuous vessels at the distal portion of this artery is suggestive of Meckel's diverticulum and can be confirmed by selective catheterization of the artery (Fig. 6) [13]. Meckel's diverticulum can be detected on angiography even in the absence of acute bleeding based on identification of the remnants of primitive vitelline arteries.
Fig. 1: (A) Spot compression view of a small bowel follow-through demonstrates a blind-ending ‘clover-shaped’ outpouching (black dotted circle) arising from the distal ileum in the right lower quadrant abdomen. Barium contrast is seen filling this diverticulum with multiple filling defects within it. (B) Oral and IV contrast enhanced coronal CT image of the abdomen in the same patient shows the corresponding ‘clover-shaped’ blind ending sac (white dotted circle) arising from the distal ileum filled with oral contrast.

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Fig. 2: Photograph of gross pathology specimen in the same patient shows a 'clover-shaped' hemorrhagic Meckel's diverticulum (black arrow) arising from adjacent ileum (white arrow).

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**Fig. 3:** (A) Supine abdominal radiograph demonstrate multiple dilated loops of small bowel (white arrows) with gas in the rectum suggesting an early or incomplete small bowel obstruction. Note is made of multiple enteroliths in the right hemiabdomen (black arrow). These can easily be mistaken for multiple gall stones in the right upper quadrant which are usually more common. (B) Unenhanced coronal CT image of the same patient reveals multiple dilated proximal loops of small bowel (white arrows). The point of transition is at a distal ileal outpouching containing multiple densities (white dotted square) surgically proven to be Meckel’s diverticulum containing multiple impacted enteroliths. (C) Bone window of the same image in Figure 3B again demonstrates the calcified nature of these enteroliths.

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Fig. 4: Anterior Te-99m pertechnetate Meckel scan shows accumulation of radioactivity in the RLQ (white arrow) due to some ectopic gastric mucosa. The intensity of radiotracer uptake is similar to that of stomach (curved white arrow), with typical appearance and location of a Meckel’s diverticulum. Note is also made of faint activity in the lower mid abdomen due to a small pooling of blood in the large bowel (black arrow) distal to the Meckel’s diverticulum from active gastrointestinal bleeding.
**Fig. 5:** Contrast enhanced axial (A) and coronal (B) images of the abdomen reveal marked focal inflammatory changes in the distal small bowel (white dotted circle) with a tiny outpouching along the antimesenteric surface and significant adjacent stranding (white arrow). There is also a small focus of extraluminal gas (open white arrow) suggestive of a perforated Meckel’s diverticulum, later confirmed by surgery. The appendix (A)(curved white arrow) is normal in appearance.

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**Fig. 6:** (A) Digital subtraction angiography with selective angiogram of the ileocolic artery demonstrates blush of contrast from a distal ileal artery (black arrow) in the right lower quadrant in keeping with active bleeding. (B) Digital subtraction angiography demonstrates superselective catheterization and embolization of the distal ileal artery with two pushable platinum coils (white arrow). Courtesy: Dr. M. Azeemuddin, Dept of Vascular & Interventional Radiology, Aga Khan University Hospital, Karachi, Pakistan.

Conclusion

Meckel's diverticula are typically asymptomatic in adults and are often found incidentally on laparotomy or on abdominal CT or MRI examinations. Complicated Meckel's diverticula are a diagnostic challenge for both the clinician and radiologist. This is both due to variable success in localizing the diverticulum itself with diagnostic imaging and also due to nonspecific clinical features, mimicking many other conditions.

Complications of Meckel's diverticula in adults may present as bowel obstruction, diverticulitis, perforation, gastrointestinal bleeding and rarely a neoplasm. Different imaging modalities such as radiography, barium study, computed tomography, scintigraphy, and angiography are used to help detect and diagnose these complications in adults. It is therefore critical to remain mindful of this important and often overlooked diagnosis.
References


