Small Bowel Diverticulosis: the great forgotten. Radiologic features and complications

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Learning objectives

To review characteristics, physiopathology and epidemiologic details of small bowel diverticulosis.

To describe imaging techniques used in diagnosis of small bowel diverticulosis and evaluation of acute complications.

To describe and illustrate radiological features of uncomplicated and complicated diverticula.
Background

A diverticulum is a sacular protrusion of the mucosa through the muscular intestinal wall in any portion of the gastrointestinal tract. The presence of multiple diverticula is called diverticulosis.

These herniations occur in weakened points of the intestinal wall where the vascular structures enter into the muscle layer. Except the Meckel’s diverticulum, unique true diverticulum composed of all of the intestine’s layers, the rest are false diverticula or pseudodiverticula, composed of mucosa and submucosa covered of serosa.

Small intestine diverticular disease is much less common than colonic diverticular disease. They can be found in duodenum, jejunum and/or ileum. Duodenal diverticula are approximately five times more common than jejunoileal diverticula.

Meckel’s diverticulum has characteristic origin, clinical features and complications and will be discussed apart.
Findings and procedure details

ETIOLOGY

The cause of this condition is unknown. It is believed that the diverticula develop as the result of abnormalities in peristalsis, intestinal dyskinesis and high segmental intraluminal pressures.

Risk factors related with small bowel diverticulosis is low-fiber and high-fat diet, advanced age, systemic sclerosis, visceral myopathy and neuropathy.

The diverticula emerge on the mesenteric border of the small bowel, in weakened points of the intestinal wall where mesenteric vessels penetrate in the muscular layer. Fig. 1 on page 12

EPIDEMIOLOGY

The real incidence is unknown because they are usually asymptomatic. All extraluminal diverticula, except Meckel’s diverticulum, are acquired. The incidence is closely related with age. The majority of duodenal diverticula are observed in patients aged > 50 years, while jejunoileal diverticula are often observed in patients aged > 60 years.

There is no predilection by race or gender, however there is a preponderance of jejunoileal diverticula in males.

Duodenal diverticula have been reported in 2-5% of patients undergoing barium studies of the upper gastrointestinal tract and in 7% of patients undergoing endoscopic retrograde cholangiopancreatography (ERCP).

Jejunal diverticula have been reported in up to 1-2% of patients in autopsy series.

In one retrospective review of 208 patients with symptomatic small bowel diverticulosis, diverticula were located in the duodenum in 79%, in the jejunum or ileum in 18%, and in all three segments in 3%.

1.- SPECIFIC FEATURES OF DIVERTICULA BASED ON ANATOMIC LOCATION AND TYPE:

A. DUODENAL DIVERTICULUM
Duodenal diverticula usually occur within 2 cm of the ampulla of Vater (juxtapapillary) (75%). Less than 10% of duodenal diverticula are located in the first and fourth part of the duodenum. The vast majority of duodenal diverticula are extraluminal, they vary from a few millimetres to several centimetres and may be multiple. Fig. 2 on page 12

This anatomic location is of clinical significance because it is associated with increased incidence of biliary stones, pancreatitis, and biliary and pancreatic anomalies Fig. 3 on page 13. The incidence increases with age. Fifty percent of cases have associated colonic pseudodiverticulosis. Haemorrhage and pancreatico-biliary disease are the most common complications.

**B. JEJUNOILEAL DIVERTICULA**

Small bowel diverticula are more common in the jejunum that in the ileum (79% jejunum, 18% ileum y 3% both) and are multiple in 75% of patients Fig. 4 on page 14. They associate colon diverticula by up to 61% of cases, duodenal diverticula by up to 30% Fig. 5 on page 15 and oesophagus diverticulum in 2.3%.

Diverticula usually are multiple and vary from a few millimetres to 10 cm Fig. 6 on page 16 and are frequently associated with small intestine motility disorders, such as progressive systemic sclerosis, visceral myopathy, and visceral neuropathies. Diverticulitis and perforation are the most common complications of jejunoileal diverticula.

**C. INTRALUMINAL DIVERTICULA**

Intraluminal diverticula are congenital diverticula resulting from incomplete canalization of duodenal lumen during fetal development. These structures are believed to start as a fenestrated diaphragm that, over time, transforms into a diverticulum as a result of peristalsis. It occurs singly and has duodenal mucosa on both sides. Intraluminal diverticula are usually located in the second part of the duodenum lined on both sides with duodenal mucosa and an eccentric opening is usually proximal in the sac. The intestinal obstruction is the most commonly associated complication.

**2.- CLINICAL MANIFESTATIONS**

Most of patients with small bowel diverticulosis are asymptomatic but may present abdominal discomfort, rectal bleeding, disorders of intestinal transit, malabsorption, meteorism. Approximately 40% of patients with jejunoileal diverticula present with symptoms of malabsorption due to small intestinal bacterial overgrowth.

In case of mayor complications they may present abdominal pain, fever, distension, nausea, vomiting, peritoneal irritation...
3.- IMAGING STUDIES

In most of cases, diverticula are incidental findings in radiologic studies.

1. **PLAIN ABDOMINAL RADIOGRAPHS AND/OR CHEST RADIOGRAPHS:** Demonstrate evidence of perforation (free peritoneal air) or intestinal obstruction (bowel dilatation with air-fluid levels).

2. **GASTROINTESTINAL FLUOROSCOPIC STUDIES WITH ORAL BARIUM:** Demonstrate diverticula by up to 2% of gastrointestinal tract studies with barium. They are useful diagnosing uncomplicated cases, but contraindicated if acute diverticulitis or perforation is suspected. Filling defects in diverticula may represent enteroliths or foreign bodies.

3. **ABDOMINAL COMPUTED TOMOGRAPHY (CT):** Small intestine diverticulosis is a rare diagnostic with CT, probably because of a combination of factors that include their similar aspect to the small bowel loops in the axial plane, and the low index of suspicion of a rare entity, asymptomatic in most of cases. Diverticula can be full of air and/or fluid or iodinated contrast and/or debris and the wall is thin and smooth Fig. 7 on page 17 and Fig. 8 on page 18. Some of them can contain enteroliths up to some centimetres of diameter Fig. 9 on page 19.

CT provides more information in uncomplicated and complicated cases. We can identify phlegmon, abscess and ascitis in cases of diverticulitis or extraluminal air in cases of perforation.

4. **MESENTERIC ANGIOGRAPHY:** Mesenteric arteriography is useful in patients with severe/massive bleeding and hemodynamic compromise. Requires bleeding rates > 0,5 ml/min. Allows embolization treatment.

5. **BLEEDING SCAN:** to identify small bleeding points.

6. **ENDOSCOPIC RETROGRADE CHOLEDOCHOPANCREATOGRAPHY** demonstrates periampullary diverticula.

7. **CAPSULE ENDOSCOPY:** should be avoided in acute diverticulitis, perforation, or small bowel obstruction.

4.- MAYOR COMPLICATIONS

Patients with small bowel diverticulosis may occasionally present with symptoms due to a complication. Although the true incidence is unclear, retrospective studies suggest that the risk of complications is higher with jejunoileal diverticula as compared with duodenal diverticula.
Mortality is influenced by the patient age, the kind of complication and the time elapsed before treatment.

These complications include:

A. DIVERTICULITIS

Is the most common complication (up to 6.4% of patients with small bowel diverticula) and may associate perforation. As the colonic diverticulitis, they are different grades of severity from inflammatory changes in mesenteric fat, perforation, abscess formation and diffuse peritonitis. Fig. 10 on page 20, Fig. 11 on page 21 and Fig. 12 on page 22.

Clinical presentation is not specific and includes abdominal pain, fever and leukocytosis. The suspected pathology is acute appendicitis, perforated peptic ulcer, acute cholecystitis or acute colonic diverticulitis.

The radiological differentials include intestinal perforation, acute appendicitis, and infectious/inflammatory ileitis (including Crohn´s disease).

B. GASTRONTESTINAL HEMORRHAGE

Diverticular bleeding of the small bowel is rare and occurs primarily in adults aged more than 60 years. Bleeding is more frequent in duodenal diverticula. Caused by the erosion and ulceration of diverticulum mucosa. The clinical presentation may be acute as rectal bleeding, melena or hematemesis, or chronic as anemia.

The differential diagnosis includes small bowel angiodysplasia, tumors, ulcerated lesions (Crohn´s disease, celiac disease)...

Gastrointestinal bleeding scan may be useful in patients with small amounts of active or intermittent bleeding. Mesenteric arteriography is useful in patients with massive bleeding and hemodynamic compromise. Requires bleeding rates > 0.5 ml/min.

C. GASTROINTESTINAL OBSTRUCTION

As a result of a complicated diverticulitis or enterolith formation.

D. ACUTE PERFORATION

Almost always associated to diverticulitis Fig. 13 on page 23 and Fig. 14 on page 24, but perforation may be produced by the impaction of foreign bodies or traumatic perforations. Herrinton described that perforation of diverticula is related with inflammatory necrosis (82%), trauma (12%) and foreign body (6%).
Complications associated with perforations are fistula, pneumoperitoneum and abscesses.

### E. PANCREATIC OR BILIARY DISEASE

Juxtapapillary duodenal diverticula appear to be a risk factor for gallbladder stones, bile duct stones and their recurrence.

The common duct may drain directly into a diverticulum at the ampulla of Vater, which can produce bile stasis, stone formation or infection.

Other mechanism of obstruction is due to compression of the intraduodenal portion of the common duct by a diverticulum distended with duodenal contents, which originates adjacent to the ampulla of Vater.

Increased complication rate of endoscopic interventions of the bile duct system, have also being described.

### 5.- MINOR COMPLICATIONS

Most of small bowel diverticulosis are asymptomatic but some authors relate them with chronic symptoms of malabsoption, abdominal pain, diarrhoea due to perturbation with peristalsis and normal propulsion of the intestinal content.

The ectasia of the intestinal content in diverticula facilitates the bacterial overgrowth associated with steatorrhoea, malabsorption of fat-soluble vitamins and degradation of the B12 vitamin (megaloblastic anemia).

### 6.- TREATMENT

The goal of treatment is based on reducing intestinal spasms with a diet rich in fibbers. Diverticulosis does not require surgical intervention.

However, giant diverticula do require surgical intervention because they are more likely to become infected and perforated.

In cases of diverticulitis conservative treatment can be considered with absolute diet and broad-spectrum antibiotics. Complicated cases require surgical treatment.

Endoscopic treatment is the most common first-line treatment for bilio-pancreatic complications caused by juxtapapillary diverticula and also for bleeding. Conservative treatment of perforated diverticula based on fasting and broad-spectrum antibiotics may be offered in some selected cases when diagnosis is made early in stable patients, or in
elderly patients with comorbidities who are poor operative candidates. Surgical treatment is currently reserved for failure of endoscopic or conservative treatment.

Early surgery is the treatment of choice for patients with intestinal perforation.

7. MECKEL’S DIVERTICULUM

The Meckel’s diverticulum was named after the German anatomist Johann Friedrich Meckel in 1808 established its embryonic origin and pathological characteristics, but, previously, it was described by Fabricus Heldanus in 1650 and reported by Levator in 1671 and by Ruysch in 1730.

This embryonic remnant is caused by the incomplete obliteration of the omphalomesenteric duct between the 5th and 7th week of gestation.

Is the only true diverticulum containing all layers of the bowel wall and arises from the antimesenteric border of the small bowel.

A.- EPIDEMIOLOGY

Is the most common congenital anomaly of the small bowel, occurring in 2% of the population, according to autopsy reviews.

The male:female ratio is 2:1.

B.- CHARACTERISTICS

The average of length is 3 cm but 90% of cases range between 1 and 10 cm. Large diverticula are more susceptible to complications. Fig. 15 on page 25

The Meckel’s diverticulum is typically found within 100 cm of the ileocecal valve, with an average distance in adults of 67 cm and in children under 2 years of 34 cm.

Approximately 60% of Meckel’s diverticula contain heterotopic mucosa, of which over 60% consist in gastric mucosa. Pancreatic mucosa (5%), colonic mucosa, endometriosis and hepatobiliary tissue, can also be found.

C.- CLINICAL MANIFESTATIONS

The clinical diagnosis of Meckel’s diverticulum is rarely impossible, because symptoms are not specific and its presentation commonly mimics such disorders as appendicitis, peptic ulcer disease and Crohn’s disease. Only 10% are diagnosed preoperatively.
The rest are incidental findings during laparotomy for other causes, such as acute appendicitis.

D.- IMAGING STUDIES

Radionuclide scintigraphy will detect 85% of Meckel’s diverticulum if gastric mucosa is present in it. Fig. 16 on page 26

Gastrointestinal tract studies with barium may also detect a smaller percentage of diverticula. The diverticulum can be identified as a sacular structure in the antimesenteric border of the ileum, usually in the right lower quadrant or pelvic region. Fig. 17 on page 27

With CT, Meckel’s diverticulum is difficult to distinguish from normal small bowel in uncomplicated cases. We can see a blind-ending structure filled with fluid or air in continuity with the small bowel Fig. 18 on page 28 - Fig. 19 on page 29 - Fig. 20 on page 30 - Fig. 21 on page 31 ). Abdominal CT is used for complicated cases.

E.- COMPLICATIONS

The lifetime risk of complications of a Meckel’s diverticulum is approximately 4 to 6%. Most of them are diagnosed in the first 2 years of life, and the probability of becoming symptomatic decreases with age.

1. HEMORRHAGE

Gastrointestinal bleeding is the most frequent complication (about 20-30% of all complications) and it is the most frequent clinical presentation in children, mainly due to the presence of heterotopic acid-secreting gastric mucosa in the diverticulum. Bleeding may range from minimal, recurrent episodes of hematochezia to massive, shock-producing hemorrhage.

When a patient presents with painless lower gastrointestinal bleeding, Meckel’s diverticulum should always be suspected. Fig. 22 on page 32

2. INTESTINAL OBSTRUCTION

Observed in 20-25% of patients with symptomatic Meckel’s diverticulum, intestinal obstruction is the most frequent clinical presentation in adults, mainly due to intussusception Fig. 23 on page 33 or intestinal volvulus, and more rarely due to diverticulitis, diverticular torsion, Littré’s hernia (abdominal wall hernia that involves the Meckel’s diverticulum) or enterolith.
3. INFLAMATION

This condition develops in approximately 10-20% of patients with symptomatic Meckel´s diverticulum. Mimics acute appendicitis and should be considered in the differential diagnosis of a patient with right lower quadrant pain. The inflammation may be precipitated by the obstruction of the diverticulum by a foreign body or enterolith or by peptic ulceration-related inflammation and scarring. Fig. 24 on page 34 - Fig. 25 on page 35 - Fig. 26 on page 36 - Fig. 27 on page 37

4. PERFORATION

Commonly results from progressive diverticulitis. Also reported secondary to a calculus and fish thorn.

Retroperitoneal abscess formation has been reported as a rare complication of Meckel´s diverticulum perforation.

5. TUMORS

Tumors of Meckel´s diverticulum are very rare and the most common tumors are leiomyoma, leiomyosarcoma and carcinoid tumor.

6. UMBILICAL ANOMALIES

These occur in up to 10% of patients and consist of fistulas, sinuses, cysts, and fibrous bands between the diverticulum and the umbilicus. Patients can present with a chronic discharging umbilical sinus superimposed by infection or excoriation of periumbilical skin. Cannulation and injection with radiographic contrast help to delineate the entire tract and aid in planning a surgical approach for cure.

F. - TREATMENT

Surgical resection is considered the treatment of choice for the symptomatic Meckel´s diverticulum. Whether an asymptomatic diverticulum should be resected is controversial topic.
Fig. 1: Small bowel diverticula

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Fig. 2: Duodenal diverticula

Upper gastrointestinal exam with barium in which we can appreciate a big duodenal diverticulum in the second portion (orange arrow) and few more diverticula of variable size in distal duodenum and proximal jejunum (white arrows).

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**Fig. 3:** Duodenal diverticulum

CT scan of a big duodenal diverticulum located in the second portion of the duodenum (juxtapapillary). This anatomic location is of clinical significance because it is associated with increased incidence of biliary stones, pancreatitis, and biliary and pancreatic anomalies.
Fig. 4: Jeunal diverticulum

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Fig. 5: Duodenal and jejunal diverticula

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**Fig. 6:** Massive jejuno-ileal diverticulosis

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Fig. 7: Jejunal diverticula appearance with CT

Axial CT images of different patients with jejun-ileal diverticula. They can be filled with air (A), air and iodinated contrast (or liquid) forming an air-fluid level (B), iodinated contrast or fluid (C) and/or debris (D). They present thin and smooth walls. It is not always possible to identify the neck union with bowel.
**Fig. 8**: Ileal diverticulum appearance with CT

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Fig. 9: Enterolith formation in an ileal diverticulum

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Fig. 10: Acute jejunal diverticulitis

63 years-old woman with mesogastric abdominal pain and rectal bleeding. Blood test show mild leukocytosis and C-reactive Protein elevation (200).

Isolated jejunal diverticulum of 10 mm in the mesenteric border (white arrow), ill-defined, with fat stranding adjacent to the diverticulum, without associated extraluminal air or fluid, consistent in acute diverticulitis.
68 years-old male with 2-days history of diffuse abdominal pain and abdominal tenderness on the left side with clear rebound. He was febrile (38°C), white-blood count was 20.700/mm3 and C-reactive protein 96.

In CT scan we can appreciate multiple diverticula in jejunum (some marked with white arrows) filled with air and air-iodinated contrast levels, and extensive inflammatory changes in adjacent mesenteric fat with extraluminal air (contained perforation) (orange arrow), consistent in acute diverticulitis.

Intraoperative image corresponding to the necrotic perforated diverticulum.

**Fig. 11:** Acute jejunal diverticulitis

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85 years-old patient with 2-days history of abdominal pain in the lower right quadrant with fever and leukocytosis. Suspicion of acute appendicitis.

CT scan reveals a small ileal diverticulum filled with fluid (white arrow) with surrounding fat stranding and parietal thickening of adjacent ileum, congruent with acute ileal diverticulitis. We can also see small bubbles of extraluminal air near the diverticulum (orange arrows).

**Fig. 12:** Acute ileal diverticulitis

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59 years-old male with abdominal pain in upper left quadrant, febricula and leukocytosis (14,000/mm3 approx.)

CT scan shows a jejunal diverticulum filled with an air-iodinated contrast level (white arrow) with slight fat stranding and extraluminal air (orange arrows), consisting in a perforated diverticulum.

A and B images correspond to the surgical specimen. We can see the diverticulum (black arrows) and inflammatory changes in the adjacent mesenteric fat (red arrows).

**Fig. 13:** Acute jejunal diverticulitis with perforation

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Fig. 14: Acute ileal diverticulitis and perforation

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**Fig. 15**: Meckel’s diverticulum

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Fig. 16: Meckel’s diverticulum. Technetium-99m pertechnate radioisotope scanning.

Technetium-99m pertechnate radioisotope scanning corresponding to the patient of the fig. 15. There is a focal uptake in the periumbilical region (orange arrow) at 5 hours corresponding to the Meckel’s diverticulum.

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Fig. 17: Meckel’s diverticulum. Gastrointestinal tract exam with barium.

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Fig. 18: Non complicated Meckel’s diverticulum appearance with CT

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Same patient of fig. 18 in a further CT, after the resolution of the acute ileitis episode that caused the previous study. We can appreciate the variability in the appearance of Meckel’s diverticulum (white arrows).

**Fig. 19:** Non complicated Meckel’s diverticulum appearance with CT

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Fig. 20: Non complicated Meckel’s diverticulum appearance with CT

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53 years-old woman who came to the emergency department with diarrhoea and right abdominal pain.

In CT scan we can appreciate an ileal diverticulum (white arrows) close to the ileocecal valve with a blind-ending morphology (green arrow), without associated inflammatory changes, consistent with Meckel’s diverticulum (confirmed with pathological anatomy). The patient presented diffuse thickening of right colon congruent with infectious colitis.

Fig. 21: Non complicated Meckel’s diverticulum appereance with CT

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Fig. 22: Meckel’s diverticulum complicated with hemorrhage

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Fig. 23: Meckel’s diverticulum complicated with intussusception and intestinal obstruction.

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Fig. 24: Meckel’s diverticulum complicated with acute diverticulitis.

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26 years-old man with right lower quadrant abdominal pain, fever and leukocytosis, with suspicious acute appendicitis.

In the CT scan performed after ultrasound, we can appreciate a blind-ending fluid-filled structure in continuity with ileum (white arrows), showing parietal contrast uptake and associated with inflammatory changes in the mesenteric fat (green arrow), congruent with acute diverticulitis of a Meckel’s diverticulum. (confirmed in surgery)

Fig. 25: Meckel’s diverticulum complicated with acute diverticulitis.

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Fig. 26: Meckel’s diverticulum complicated with acute diverticulitis.

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56 years-old man attended in the emergency room with right abdominal pain, leukocytosis and fever.

In CT scan we can see a tubular ileal diverticulum (white arrows) with associated inflammatory changes in mesenteric fat and an abscess close to the tip of the diverticulum (green arrows). Surgical intervention demonstrated acute perforated diverticulitis of a Meckel’s diverticulum.

**Fig. 27:** Meckel’s diverticulum complicated with acute diverticulitis.

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Conclusion

Diagnosis of small bowel diverticulosis is difficult and is often missed or delayed although is quite frequent entity (about 5%).

Complicated small bowel diverticulosis can present as acute abdominal pain and should always be considered in the differential diagnosis of acute abdominal findings on examination or cross-sectional imaging.
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Fig. 28: personal information

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Fig. 29: References

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