Barium examination of gastrointestinal diverticula.

Poster No.: C-1362
Congress: ECR 2014
Type: Educational Exhibit
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Keywords: Diverticula, Education, Barium meal, Barium enema, Plain radiographic studies, CT, Gastrointestinal tract
DOI: 10.1594/ecr2014/C-1362

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Learning objectives

Explain the main imaging characteristics of the different kinds of diverticula in the gastrointestinal tract with barium examination.

Review the different barium exam techniques with an emphasis on diverticular disease findings.

Describe the pathophysiology of the main kinds of diverticula, their association with other diseases and complications.

Background

Gastrointestinal diverticula are a very heterogeneous pathology. They have no specific symptoms and their complication can mimic other causes of acute abdominal pain. They often are incidental findings in radiological examinations.

The prevalence in the general population may range from very common; for example, colonic diverticular disease, to very rare, such as gastric diverticulum.

A diverticulum can be classified in two main groups, true and false.

All the gastrointestinal wall layers compose a true diverticulum. They are often congenital abnormalities or traction diverticula.

False diverticula are the most common type. Only few gastrointestinal wall layers compose them. The increase of intraluminal pressure facilitates mucosal outpunching through the weakest point of the muscle wall, such as the blood vessels penetration site.

Infection, inflammation, perforation and neoplasms are the main complications and can affect all the diverticula kinds with different frequency.

Barium (barium sulfate) is exclusively used in gastrointestinal radiology as an intraluminal contrast material. Several commercial barium preparations exist; density, quantity and route of administration may vary according to the gastrointestinal segment to be evaluated.
The first phase of barium examination, or "single contrast", consists in filling the organ lumen with barium suspension to allow the recognition of gross structural abnormalities. In the second phase, called "double contrast", most of the barium suspension should be evacuated from the organ lumen, a thin layer of barium remains attached to the mucosa and then, effervescent agents, carbon dioxide or air can be used to distend the lumen. This technique specially helps to recognize subtle abnormalities in the mucosa pattern.

Fluoroscopy and recording modalities as serial radiographs must be used to achieve a correct documentation of the study.

Small or narrow neck diverticula can be missed in an endoscopy; if they are collapsed cross-sectional imaging modalities such as CT o MRI may not clearly distinguish them.

The barium examination of gastrointestinal tract is safe and dynamic. Real time exams allows the radiologist to evaluate the findings in the moment of the study in order to resolve doubts with a high diagnostic accuracy.

Findings and procedure details

Esophagus

Barium swallow is the first exam in the study of esophageal diseases. Barium studies of the esophagus are usually multiphasic examinations that include upright double-contrast and prone single-contrast. To archive the double contrast the patient first ingests an effervescent agent and then rapidly gulps high-density barium in the upright left posterior oblique position [figure 1] [1]. Additional projections can be used to characterize the number, distribution and size of diverticula. Esophageal motor disorders should always be ruled out in this scenario.

Cervical esophagus

Zenker diverticulum is a false diverticulum with the highest prevalence in the elderly. An increased cervical esophagus intraluminal pressure, due to cricopharyngeal pathology is the main cause [2].
Symptoms derived from the food retention in the diverticulum like halitosis, regurgitation, foreign-body sensation and aspiration pneumonia [2,3]. Intradiverticular carcinoma has been reported and should always be ruled out [4].

Zenker diverticulum is better visualized in lateral projections [figure 2]. It arises from the posterior wall of the cervical esophagus, has a narrow neck and variable caudal extension. When the diverticulum is filled with barium an anterior compression of the esophagus and a fluid-fluid level can be seen [2].

Traction diverticula are caused by adhesion of the esophageal wall to inflammatory processes in the deep cervical planes; surgery is the most common antecedent [2].

Lateral diverticula, also known as Killian-Jaimenson diverticula, are frequent in patients with dysphagia; they arise from the anterolateral portion of the esophagus under the transversal part of the cricopharyngeal muscle.

Thoracic esophagus

Thoracic esophagus are almost exclusively traction diverticula due to adherences to mediastinal ganglia affected by granulomatous diseases such as tuberculosis or histoplasmosis [2,5].

They are usually asymptomatic. Complications are rare but serious, like mediastinitis and tracheoesophageal fistula [1].

Traction diverticula are acquired; they can be visualized well in oblique projections [figure3] (2).

Distal esophagus

Epiphrenic diverticula constitute less than 10% of esophageal diverticula.

They are false, associated to increased pressure, consequence of structural and motor disorders as achalasia, esophageal spasms and hiatal hernia [figure 4].

They are often incidental findings [figure 5] [1]. Symptoms are uncommon, but dysphagia due to compression and halitosis due to food retention can be found when they reach a large size.
Intramural pseudodiverticula are dilated excretory ducts of the deep esophageal glands [figure 6][1,3]. A strong association with acid peptic disease exists [3]. They are identified as 1-3 mm barium deposits within the esophageal wall without apparent connection to the lumen, they seem to float [figure 7] [1,2,5].

**Stomach**

**Gastric examination** starts with a small high-density barium swallow, in order to evaluate the mucosal folds and esophageal patency. Turning to decubitus supine position the patient turns around 360° in order to coat all the gastric mucosa with barium. Effervescent agents are given to achieve the double contrast [figure 8].

Two basic positions are described:

- **Schatzki**: decubitus prone, right oblique with caudo-cephalic x-ray beam angle.
- **Hampton**: decubitus supine, left oblique with cefalo-caudal x-ray beam angle.

These positions help to displace the barium pool and air, in order to characterize the different gastric areas. Complementary projections and positions may be used.

Gastric diverticula are very uncommon. They are found in the 0.4% of the upper gastrointestinal series, with the highest incidence in the 5th and 6th decades of life [6].

Symptoms are non-specific. Epigastric abdominal pain, bloating, early satiety, bleeding and even perforation have been described mimicking acid peptic disease [6].

75% of gastric diverticula arise from the posterior part of the fundus or next to the cardias [figure 9] [6]. Endoscopy may misdiagnose them as a paraesophageal or diaphragmatic hernias [7]. In a tomography they may mimic cystic pancreatic, adrenal or renal lesions when they are filled with liquid [6,7].

True gastric diverticula are probably congenital, localized in the fundus and are the most common type [6]. False diverticula are associated to chronic gastric outlet obstruction, like peptic pyloric stenosis or distal gastric cancer [6]. Traction diverticula are associated with perigastric inflammatory process like pancreatitis or surgery [6].

Gastric diverticulum size is usually between 3-10 cm [8,9]. Double contrast should be used to evaluate internal mucosa characteristics in order to exclude inflammatory changes or a tumor.
A narrow neck diverticulum with a very high location may not be filled with barium, and become evident only in the double contrast phase of the study [6].

Lateral projections should depict its subdiaphragmatic location, in order to establish the differential diagnosis with a diaphragmatic hernia [figure 10].

**Small bowel**

**Duodenum**

**Duodenal diverticula are incidental findings in 10% of the upper gastrointestinal barium exams** [10]. The duodenum should be filled with enough barium to evaluate the arcade amplitude and filling defects or deposits. This can be usually achieved by asking the patient to adopt the Schatzki position. Duodenal clearance is fast, so high frame rate videofluoroscopy is very helpful.

**Double contrast may help visualize small diverticula. When effervescent agents are administrated, the patient should turn to decubitus prone position, moving the gas through the pylorus distending the duodenum.**

Most of the duodenal diverticula are acquired [2]. Their frequency is higher in women over 40 years old [11]. Small diverticula can be confused with ulcers, absence of inflammatory changes in duodenal mucosa helps to make the correct diagnosis [2].

Intraluminal duodenal diverticulum is a congenital abnormality caused by an incomplete recanalization of duodenal lumen in the embryogenesis [2, 10, 14]

Clinical symptoms are not specific. Acute complications may mimic pancreatitis, colecystitis or peptic acid disease [2,12]. When perforation occurs, gas will distribute to the retroperitoneal space. Large size diverticula are cause of upper bowel obstruction [2,12].

Duodenal diverticula can be associated with inflammatory bile duct pathology when they are located in the proximity to the ampulla of Vater [11, 12].

Morphologically, duodenal diverticula are round shaped with a wide neck [figure 11]. They can disappear with position changes during the barium exam [2]. They are located mainly around the ampulla and can vary in number and size [figure 12] [2,10].
Intraduodenal diverticulum shows a characteristic radiolucid contour. It is also known as the "halo" or "wind sock" sign [14].

**Jejunum and Ileum**

**Enteroclysis** is the specific barium exam of the small bowel. After naso-enteral tube placement with the distal tip in the jejunum, a barium suspension is administered at a rate sufficient to maintain small bowel distention. Double contrast can be achieved with the administration of hi-density barium and 0.5% hydroxypropyl methylcellulose solution under fluoroscopic guidance [15]. Manual or mechanic compression helps to displace bowel loops and characterize every intestinal segment. An alternative to enteroclysis is the oral administration of barium.

Diverticulosis of the jejunum and ileum is an uncommon entity, with a reported frequency of 0.3-1.9% in barium studies [16,17].

Eighty percent of small bowel diverticula occur in the jejunum, 15% in the ileum and 5% in both [18].

Pathogenesis is multifactorial. They represent false diverticula at points of entrance of blood vessels on the mesenteric side of the small bowel. Small bowel peristalsis disorders have been reported in association with this pathology [2].

The majority of patients with this entity have no symptoms. Only 6-10% of patients present with no specific symptoms, such as malabsorption, hemorrhage, inflammation or obstruction. Jejunal diverticulosis should be considered in all patients with unexplained diarrhea due to bacterial overgrow [19].

Barium studies, especially enteroclysis, show the presence of multiple rounded, variably sized barium deposits, often with discrete narrow necks [figure 13].

**Jejunul diverticulitis** can mimic perforated ulcer, appendicitis or colonic diverticulitis, and CT must be the first imaging study in this setting [20].

Ileal diverticula are far less common. Most of these diverticula lie in the terminal portion near the ileocecal valve and resemble those in the sigmoid colon [figure 14] [2].

Ileal diverticulitis is rare and clinically mimics acute appendicitis [2].
Sclerodermia affection of small bowel may mimic diverticulosis. These sacular formations have wide neck, large size and affect only one side of the bowel wall (2). Clinical history and others sclerodemia manifestations are essential for the correct diagnosis.

Meckel's diverticulum

It is the most common congenital anomaly of the gastrointestinal tract with a reported prevalence of 2-3% in the general population and is a true diverticulum [22,23].

In the embryo, the midgut temporarily communicates with the yolk sac through the omphalomesenteric duct. This communication becomes obliterated. This progressive obliteration may fail, leading to a blind outpouching [24].

Around 75% of Meckel's diverticulum are found within 100 cm of the ileocecal valve on the antimesenteric border of the ileum [2,25].

Ectopic gastric mucosa is the most common heterotopic tissue, present in approximately 20% of cases [26].

The most common symptom in children is bleeding as a result of ulceration adjacent to heterotopic gastric tissue. In adults, the most common symptom is intestinal obstruction [2,22].

On barium studies, Meckel's diverticulum appears as a blind-ending pouch arising from the antimesenteric side of the distal ileum, the junctional fold pattern can be found, described as a "mucosal triangular plateau" when the loops are distended [figure 15 A] and a "triradiate fold pattern" when the loops are collapsed [figure 15 B] [2,24].

Meckel's diverticulum may be inverted, serving as a lead point for intussusception, and appears as a soft polypoid-filling defect [2,25]. Technetium studies can be helpful to demonstrate ectopic gastric mucosa.

Colon

Colonic double contrast barium examination has been studied for several years for multiple purposes. Patients need a special preparation to clean the colon with a low-residue diet for 1-3 days, a solution that keeps enteric contents semifluid and an orally administered agent that stimulates colonic contraction. Sometimes
a cleansing enema is performed [27]. Examination should be performed with high-density barium. Commercial preparations for this purpose with a special canula are available. The exam starts in decubitus lateral position to characterize the rectum and sigmoid colon. Enough barium suspension should be administrated to correctly distend de colon lumen. Changing patient position allows barium pool displacement in order to evaluate every colon segment. For the double contrast barium excess should be evacuated, leaving just a thin layer, gentle insufflation with air or carbon dioxide provides lumen distention [figure 16]. Double contrast can detect very small diverticula [2].

Colonic diverticula are false diverticula; herniation involves the mucosal and submucosal layers [27-29].

50% of people over 80 years old have colonic diverticulosis; left colon is the most affected site [28,29]. Right side diverticulosis is more frequent in younger patients [28].

Environmental, dietetic, geographic and racial factors has been linked to diverticular disease [28,29]. Low fiber occidental diet is the most studied an accepted risk factor to develop colonic diverticulosis. It affects stool volume and intestinal transit time [20,30].

Changes in collagen bindings and abnormal elastin deposits have been reported as risk factors, they increase bowel wall stiffness increasing lumen pressure resulting in diverticula formation [30].

Patients affected with Ehlers-Danlos or Marfan syndrome present more severe colon diverticulosis at a younger age, increased bowel wall weakness is the most accepted theory [29].

Symptoms are not specific. Patients complain of diffuse abdominal pain, sometimes located in the left iliac fossa, constipation and hematochezia [20,30], Neoplastic affection should always be ruled-out when these symptoms are present.

Complications can be divided into acute and chronic. Diverticulitis is the main acute complication and can be a life-threatening condition when perforation and peritonitis are present. Chronic mild diverticular inflammation may lead to intestinal stenosis and fistula formation [31].

Colon barium enema depicts diverticula as small barium deposits with short neck and smooth internal contour [figure 17]. Size may vary from 5-10 mm up to 25 cm [figure 18]
[2,30]. This study should not be performed when an acute complication is suspected, barium may cause chemical peritonitis worsening the clinical scenario.

Images for this section:

![Fig. 1: Normal double-contrast esophagus examination.](image)
Fig. 2: Zenker diverticulum. Anterior compression of the esophagus (black arrow). Tracheal aspiration due to retention of barium in the diverticulum (white arrow).
Fig. 3: Mid esophagus diverticulum (black arrow).

Fig. 4: Epiphrenic diverticulum with a fluid-fluid level inside (white arrow). "Bird-beck" sign due to achalasia (black arrow).
Fig. 5: Wide neck epiphrenic diverticulum (black arrow).
Fig. 6: Single-contrast esophagogram showing multiple pseudodiverticula.

Fig. 7: Dilatation of deep esophageal gland duct (black arrow). Small pseudodiverticulum without apparent luminal connection (white arrow).
Fig. 8: Normal gastric double-contrast.
Fig. 9: Posterior location of gastric diverticulum (black arrow).
**Fig. 10:** Subdiaphragmatic location of gastric diverticulum (black arrow) misdiagnosed as diaphragmatic hernia by endoscopy.
Fig. 11: Duodenal diverticulum.
**Fig. 12:** Bilobulated duodenal diverticulum (black arrow).
Fig. 13: Multiple jejunal diverticula (black arrows).
Fig. 14: Ileal diverticula (black arrows) adjacent to cecum.
Fig. 15: A: Mucosal triangular plateau, distended bowel loops. B: Triradiate fold pattern, collapsed bowel loops.
Fig. 16: Normal double-contrast barium enema.
Fig. 17: Sigmoid diverticulosis (black arrows).
Fig. 18: Multiple colonic diverticula.
Conclusion

Gastrointestinal diverticula are a very heterogeneous disease, most of the time they are asymptomatic but complications, as acute inflammation or perforation, can be life-threatening conditions.

Barium exams are widely available, safe and very accurate in the evaluation of the different kinds of enteric diverticula with high diagnostic accuracy.

Personal information

References


