Air is in the wall: Radiological spectrum in gastroesophageal pneumatosis.

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Learning objectives

Review imaging features and the clinical significance of pneumatosis intestinalis (PI) in patients attended to in the emergency service of our hospital in order to emphasize the importance of a patient's clinical condition and highlight imaging findings which help differentiate between benign and life-threatening causes.
**Background**

Pneumatosis intestinalis is defined as the presence of gas within the wall of the gastrointestinal tract. This is an imaging sign instead of a specific diagnosis and is associated with numerous conditions which range from benign to life threatening. Although PI is a rare condition, this finding is now more frequently detected with the increasing use of computed tomography, and could also be due to new surgical, nonsurgical procedures (endoscopy) and medications (chemotherapy and corticotherapy) which are associated with PI. Alertness of features that may differentiate between benign and more seriously and threatening causes is critical for correct clinical management.

PI is defined as the presence of gas within the wall of the gastrointestinal tract. This is an imaging sign, not a specific diagnosis, and is associated with numerous conditions which range from benign to life threatening. Although PI is a rare finding, the increasing use of computed tomography causes it to be more frequently detected nowadays, though it could also be due to new surgical, nonsurgical procedures (endoscopy) and medications (chemotherapy and corticotherapy) which are associated with PI.
Findings and procedure details

Section: Learning objectives

CASE-1

40 year-old man arrived at the hospital with chest pain and food impaction. His medical history included HIV, type 1 diabetes mellitus and chronic alcohol related pancreatitis. After endoscopic disimpaction, a perforated esophageal ulcer was observed, which was endoscopically treated with clips. CT with oral and IV contrast was performed (Figure 1). Favorable outcome with conservative treatment.

CASE-2

A 20 year-old man entered the emergency department with dysphagia and food impaction with self-induced vomiting without improvement. His medical history included type 1 diabetes mellitus and eosinophilic esophagitis with intermittent treatment. A poorly tolerated gastroesophageal endoscopy was performed without achieving bolus disimpaction. CT with oral and IV contrast was performed (Figure 2). Favorable outcome with medical treatment and radiological improvement in imaging studies.

CASE-3

88-year-old woman showed up at the emergency department due to colic abdominal pain, nausea and fecal vomiting. Her medical history included gastric emphysema 1 year before, secondary to nasogastric tube placement and surgical history of incarcerated epigastric hernia. With the suspected diagnosis of intestinal obstruction, a CT scan was performed (figure 3). Laparotomy and adhesiolysis were performed, and nasogastric tube replacement without any complication.

Foreign object ingestion and esophageal food bolus impactions are common problems in the emergency department. Most of these resolve spontaneously,
however, 10% of ingested foreign bodies may become lodged in the esophagus and endoscopic or surgery treatment is required. The majority of esophageal food impactions (88-97%) have an underlying pathology. Benign esophageal stenosis (rings, peptic strictures, webs, extrinsic compression) and others like esophagitis and motor disorders are the most common causes. However, an important condition to recognize, especially in young people with dysphagia and impaction, is eosinophilic esophagitis (like the patient in case 2) The radiological appearance of foreign body impaction is variable. In adults, food boluses account for most cases of foreign body impaction, at CT these bolus are observed as a heterogeneous particulate material. The second most common foreign body is bone (fish, chicken, rabbit and others). These are more likely to become lodged in the hypopharynx or upper esophagus, where endoscopic visualization is complicated. CT is useful in these cases. The thin esophageal wall, lack of a supporting adventitia and poor blood supply predispose to esophageal ulceration or perforation due to foreign body impaction. In these cases imaging studies, especially CT, is useful in locating the injury, confirming the perforation or diagnosing others complications. We hypothesized that the disruption in esophageal-gastric mucosa caused by the impacted bolus (case 1 and 2) and the nasogastric tube (case 3) conditioned the dissection of air into the wall and barotrauma in relation to air insufflation. Our 3 patients complained of chest or abdominal discomfort, the clinical course was benign with conservative management, absence of complications and decrease of pneumatosis in control imaging studies after the cause was removed or treated.

CASE 4.

51-year-old male patient with a history of acute myeloid leukemia 2 years before, treated with allogenic hematopoietic stem cell transplantation. Multiple infectious complications such as neutropenic fever, cytomegalovirus intestinal infection, pseudomonas aeruginosa infection and graft-versus-host disease. The patient went to the emergency department with abdominal pain and distention. No fever, vomiting, or other symptoms. CT with IV contrast was performed (Figure 4). Laparotomy was performed with subtotal colectomy and antibiotic treatment with appropriate recovery.

The gastrointestinal tract is thought to contain latent CMV after a primary infection. After undergoing hematopoietic stem cell transplantation patients are at risk for opportunistic infections and other complications caused by dysfunction of the immune system. CMV colitis is common in patients with long-term immunosuppressive therapy. Usually it presents with nonspecific symptoms such as abdominal pain, diarrhea, intestinal bleeding, and fever. The gold standard for diagnosis is immunohistochemical testing of colon biopsy.
On CT the appearance is similar to other inflammatory or infectious intestinal diseases with mural thickening and fat stranding, ascites is seen in 50% of cases. Sometimes, no image alterations are observed, therefore biopsy is required. Murray et.al study concluded that the diagnosis should be suggested when CT shows colonic wall thickening, particularly if the thickening is associated with mural ulceration.

To date only one case of pneumatosis associated with cytomegalovirus colitis has been reported. In our case, it is associated with pneumoperitoneum, although the absence of free and pericolonic fat infiltration is noteworthy. It is important to note that in patients with chronic treatment with corticosteroids, such as that used in graft-versus-host, cases of benign pneumatosis have been reported. The possible explanation are the defects in the mucosa due to the hypertrophy in the Peyer patches and the dissection of intraluminal gas in the subserous or submucosa. CT shows pneumatosis in the intestinal wall, mesenteric and portal gas as well as pneumoperitoneum can also be seen. No free fluid or significant associated inflammatory changes are observed. In these cases the differential diagnosis includes any other cause of pneumatosis, whether inflammatory, infectious or ischemic, although the main diagnostic key is the good condition of the patient, who is usually asymptomatic.

**CASE 5.**

A 59-year-old male patient who consults at the emergency department referred by his primary care physician due to important subcutaneous emphysema in the abdomen, chest and supraclavicular region. He did not complain of any other symptoms and the hemodynamic status was normal. His medical history included unilateral lung transplantation due to idiopathic pulmonary fibrosis and, 2 weeks before, a bronchoscopy with transbronchial biopsy was done. The patient had chest X-ray 15 days earlier in which extensive pneumatosis was observed at the hepatic flexure. An unenhanced CT (Figure 5) was performed. Due to the good condition of the patient, conservative management was decided without complications.

Pneumatosis intestinalis has been described in association with pulmonary diseases (eg, chronic obstructive pulmonary disease, cystic fibrosis, bronchiectasis and artificial ventilation). The pneumatosis is originated by and rupture of alveolar injury with air dissecting the bronchopulmonary interstitium to the mediastinum, retroperitoneum and along the vascular supply of the viscera. Pneumoperitoneum, mesenteric and portal gas is usually due to a rupture of a gas filled cyst in the serosal or subserosal layer of the intestinal wall. Our search of the literature yielded no previous case reports of pneumatosis in the setting of transbronchial biopsy.
CASE 6.

A 17 year old man with a history of preterm birth, hypoxic ischemic encephalopathy, severe psychomotor retardation, spastic tetraplegia, and severe dysphagia with gastrostomy placement 6 years ago, was admitted to the hospital with complaints of diffuse abdominal pain and distension, nausea and vomiting. At physical examination the patient was in poor general condition and jaundiced, the abdomen was distended and very painful, with improvement of the symptoms after stomach aspiration. An x-ray, ultrasound, and abdominal CT were performed (Figure 6). Under the diagnostic orientation of emphysematous gastritis, hospital admission was urgently decided for conservative treatment. The patient was discharged without complications.

CASE 7.

An 82-year-old obese man with a history of prostatectomy due to benign prostatic hyperplasia and rectum adenocarcinoma operated 10 years ago was admitted to the hospital with complaints of dyspnea. In the emergency department, vocal cord paralysis was observed, so an emergency tracheostomy was performed and hospitalization was decided for the study of possible underlying neoproliferative process. During hospitalization, worsening of the general condition, tachycardia, abdominal distension and pain, leukocytosis and impaired renal function were observed. The patient suffered a cardiac arrest lasting two minutes. With suspected pulmonary embolism, a contrast-enhanced CT study was performed (Figure 7). Poor outcome despite medical treatment. Due to the medical condition of the patient, age and comorbidities and in consensus with relatives and General surgery, a non-surgical treatment was decided. On the 11th-hospital day, the patient expired.

Emphysematous is a severe and rare condition characterized by presence of gas in the stomach wall in association with clinical sepsis carries a high mortality rate of 60%. It is most frequently caused by ingestion of corrosive substances and alcohol abuse. Others predisposing factors include gastroenteritis, NSAID's, diabetes, leukemia, adenocarcinoma, pancreatitis and chemotherapy, all of which can breach the integrity of the mucosa. The most frequently involved organisms are streptococci, Escherichia coli, Enterobacter species, Pseudomonas aeruginosa and Clostridium species. The diagnosis of emphysematous gastritis can be made by the radiological demonstration of intramural gas. CT is considered the technique of choice for intramural gas detection and may also demonstrate irregular mural and fold thickening, pneumoperitoneum and portal venous gas.
It is important to differentiate emphysematous gastritis from gastric emphysema, the latter has a relatively benign course and patients are usually asymptomatic. In this case the gas enters the wall from the lumen, esophageal or duodenal connection, dissection of pulmonary gas and is usually associated with violent coughing, vomiting, or pulmonary disease. On CT imaging, the gastric mural air tends to be linear and the fold thickening is absent.

CASE 8.

A 79-year-old woman was admitted to the emergency department for melenas. Her medical history included advanced dementia and atrial fibrillation. An IV contrast enhanced CT was performed (figure 8). A rectal low anterior resection and sigmectomy was done with favorable medical evolution.

CASE 9.

A 66-year-old man was admitted to the hospital for severe epigastric pain that began after chemotherapy (cetuximab and CDDP) 5 days before. Medical history of hypopharyngeal squamous cell carcinoma treated with total pharyngolaryngectomy and radiotherapy. At physical examination the patient was in poor general condition, hypotensive with signs of peritonitis. An IV contrast enhanced CT was performed (figure 9). Due to the medical condition of the patient and comorbidities, it was decided not to perform surgical treatment, the patient died.

Complicated or life-threatening pneumatosis has multiple etiologies, with mesenteric ischemia being the most common cause. Others include are intestinal obstruction, infections, toxic megacolon or as in our case fecalomas. Some CT signs have been described that may help differentiate between complicated and benign pneumatosis. The circular form of mural air is usually reported as benign and most often seen with pneumatosis cystoides intestinalis. Linear or bubble like pneumatosis can be due to both benign and life-threatening causes and its appearance alone does not permit differentiation between benign or life-threatening pneumatosis. Additional CT signs that increase the possibility of life-threatening pneumatosis are: Distribution of the mural air within a vascular territory, wall thickening, portal or mesenteric venous gas, free intraabdominal fluid, mesenteric fat stranding, dilated bowel loops, vascular thrombosis or occlusion, visceral lesions such as infarcts.

Pneumoperitoneum can be seen in both cases, as hollow viscera perforation in life-threatening pneumatosis or in benign causes due to rupture of serosal and subserosal cysts.
Fig. 1: Figure 1. Cervical X-ray showing prevertebral air-images. Oral and IV contrast enhanced CT revealed gastric pneumatosis (blue arrow) with extraluminal air adjacent to gastroesophageal junction. Secondary pneumomediastinum and cervical emphysema was observed

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Fig. 2: CT with oral and IV contrast showing cervical emphysema, pneumomediastinum, esophagogastric pneumatosis (blue arrow) and pneumoretroperitoneum probably caused by barotrauma in the patient’s context. Bolus impacted (red arrow) in distal esophagus, with oral contrast adopting an atypical morphology, which could be located intramural (green arrow), in any case not contrast leak is observed.

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Fig. 3: X-ray showing radiolucent images in gastric wall. IV contrast enhanced CT showed dilated fluid filled small bowel all the way to the terminal ileum, where there was an abrupt cut off. Gastric and duodenal wall pneumatosis (blue arrow) with some extraluminal bubbles, probably secondary to barotrauma and microperforation due to nasogastric tube impacted at the esophagogastric junction (green arrow)

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Fig. 4: X-ray showing multiple radiolucent images near the hepatic flexure, compatible with pneumatosis. IV contrast enhanced CT showing severe colonic pneumatosis (blue arrow) except in a segment of the sigmoid colon. Pneumoperitoneum is also observed. Correct vascular permeability. No free liquid or infiltration of pericolonic fat.

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Fig. 5: Chest x-ray 15, days before the CT scan, showing multiple radiolucent images near the hepatic flexure, compatible with pneumatosis. Unenhanced CT showing pneumomediastinum, pneumoretroperitoneum, extensive colonic pneumatosisis of right and transverse colon (blue arrow), and subcutaneous emphysema. No evidence of bronchial suture dehiscence, pulmonary interstitial emphysema, free abdominal fluid or pericolonic fat stranding.

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**Fig. 6:** X-ray showing severe extra and intrahepatic portal gas (red arrow) IV contrast enhanced CT showing diffuse thickening of gastric wall with intramural gas (blue arrow), perigastric fat reticulation, portal gas (red arrow) and abundant free fluid.

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**Fig. 7:** IV contrast enhanced CT showing thickening of gastric antrum and greater curvature (red arrow) with intramural gas in gastric fundus (blue arrow). Free intraabdominal fluid and dilated fluid filled small bowel without identifying an abrupt cut off. No filling defects within the pulmonary vasculature were observed.

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**Fig. 8:** IV contrast enhanced CT showing a faecaloma in rectal ampulla, mural thickening of the rectum with mural pneumatosis (blue arrow) and perisigmoid and pelvic free air compatible with perforation, dense free fluid with particulate content suggestive of fecaloid peritonitis (red arrow).

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Fig. 9: Distended fluid filled small bowel loops with mural pneumatosis and air in splanchnic vasculature (blue arrow). Intramural gas in gastric wall (red arrow) and free abdominal fluid were also observed.

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Conclusion

PI is an imaging sign, not a specific diagnosis. The radiologist will be the first to diagnose PI, which in emergency setting this could be caused by different etiologies, either benign or life-threatening. The imaging appearance is similar in both cases, therefore, imaging findings should be evaluated according to clinical history, physical examination and additional tests.
References


