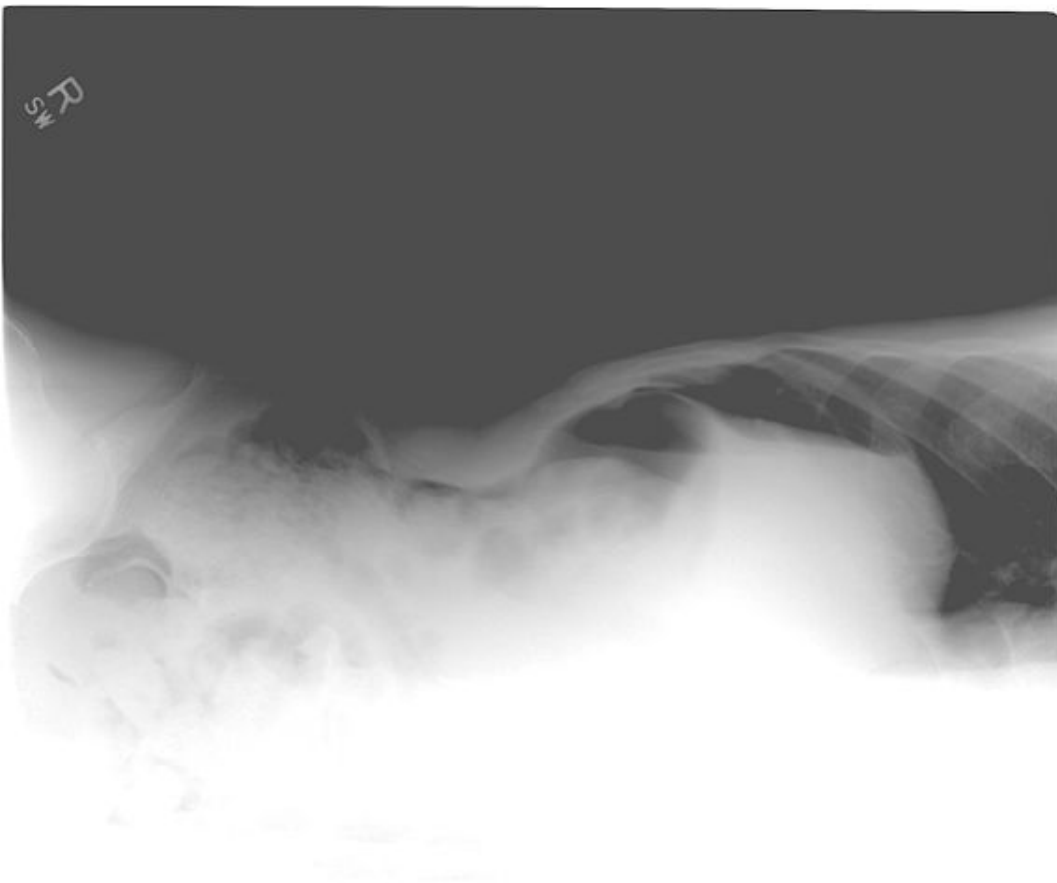


Extraluminal Air: Pneumoperitoneum & Pneumatosis Intestinalis — Radiographic Evaluation

[See online here](#)

Intraabdominal air can be seen on conventional abdominal x-rays, computed tomography scans of the abdomen or ultrasonography imaging. Intraabdominal air can be physiologic or pathologic. The most common cause of normal intraabdominal air is air within the gastrointestinal tract, i.e. the stomach bubble. Pathologic air can be further divided into the extraluminal, intraluminal, intraparenchymal or intramural air. Extraluminal pathologic air can be a pneumoperitoneum or free gas within the retroperitoneum. The most common cause of intramural air is pneumatosis intestinalis.



Pneumoperitoneum

Background

Pneumoperitoneum, defined as the **presence of free air within the abdominal peritoneal cavity**, can be a complication of intra-abdominal surgery or caused by the perforation of a viscus.

Some common causes of pneumoperitoneum among inpatients include:

- Peritoneal dialysis
- Excessive mechanical ventilation, leading to perforation of a viscus
- Mechanical perforation of a viscus after a colonoscopy or an upper gastrointestinal tract endoscopy

The causes of pneumoperitoneum in children differ from those of adults. The most common causes in children are non-iatrogenic, such as **necrotizing enterocolitis**, **Hirschsprung's disease**, and **meconium ileus**. Iatrogenic causes of pneumoperitoneum in children include rectal perforation from a rectal thermometer or mechanical ventilation-induced pneumoperitoneum.

Clinical Presentation of Pneumoperitoneum

Patients with an acute pneumoperitoneum typically present with **acute abdominal pain**, vomiting, distension, fever, and symptoms and signs suggestive of peritoneal irritation. Patients with acute viscus perforation and pneumoperitoneum also experience tachycardia, hypotension, decreased urine output, and tachypnea. The recent history of severe **peptic ulcer disease**, **appendicitis**, or trauma can be elicited in a significant number of cases.

Radiographic Evaluation of Pneumoperitoneum

An erect chest x-ray is the imaging modality of choice to screen for pneumoperitoneum. The examination is very sensitive for detecting intraperitoneal gas in an emergency setting, where more sophisticated imaging modalities might be considered harmful due to delayed treatment. Nowadays, erect chest x-rays are done in all acute abdominal cases. For example, a supine abdominal x-ray may show a **cupola or mustache sign**. Air is trapped underneath the central tendon of the diaphragm.

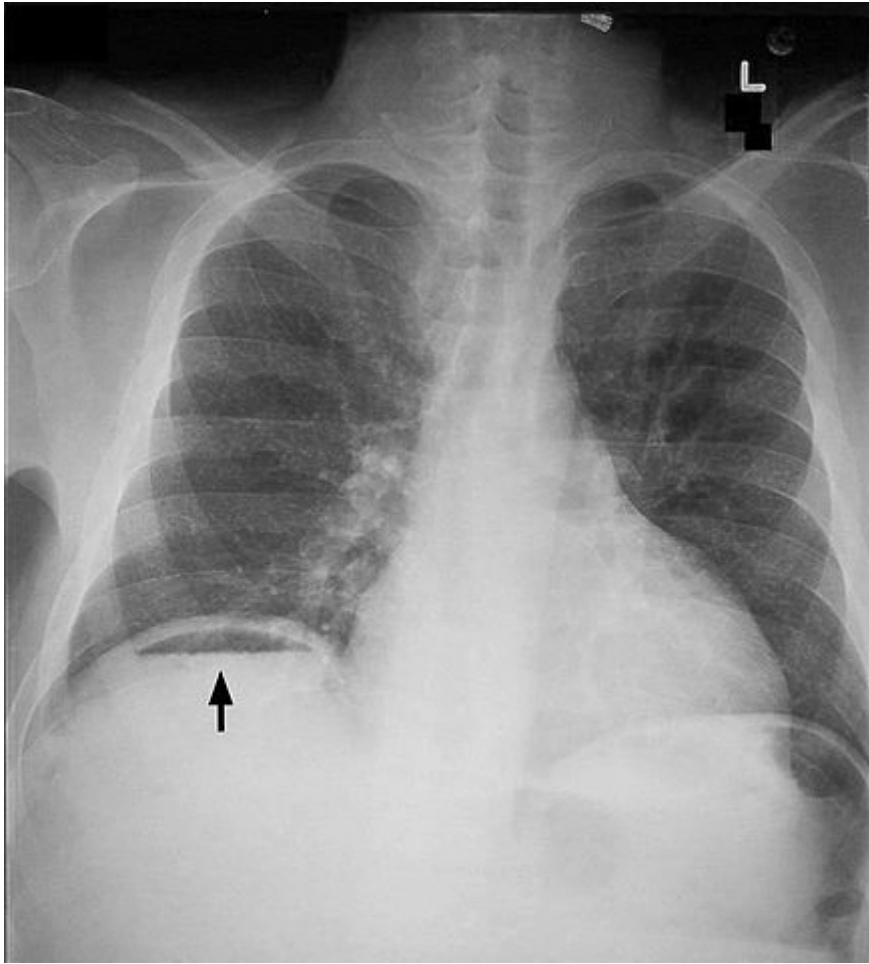


Image: "Pneumoperitoneum on chest X-ray." by Clinical_Cases. License: [CC BY-SA 2.5](https://creativecommons.org/licenses/by-sa/2.5/)

Rigler's sign shows an outline of both sides of a bowel wall. Reduced liver opacity, due to the accumulation of air anterior to the liver, is known as a **Lucent liver sign**. The free intra-abdominal air can outline the whole abdomen, i.e., **football sign**, or the falciform ligament of the liver, i.e., **Silver's sign**. The triangular collection of gas within the Morison pouch is known as **Doge's cap sign**.

Radiographic sign	Patient position
Air under the diaphragm	Upright position
Visualization of both sides of the bowel wall (Rigler sign)	Any position
Visualization of the falciform ligament (Silver sign)	Supine position

In most cases, the emergency physician simply sees sub-diaphragmatic free air on an erect chest x-ray, which is considered a specific sign of intra-abdominal free air.

When the amount of air is quite small, but the risk of viscus perforation is very high, i.e., severe penetrating trauma to the abdomen, an abdominal computed tomography scan is indicated. Small, free peritoneal air can be detected easily on abdominal computed tomography scans.

Retroperitoneal Free Gas

Background

Injury to the retroperitoneal structures, such as the coccygeal region, kidneys, ureters, or post-renal transplantation, might cause air accumulation within the retroperitoneum. Retroperitoneal free gas is more difficult to recognize on routine abdominal or chest x-rays and can be associated with severe injuries to vital retroperitoneal structures, such as the lumbosacral plexus.

Clinical Presentation of Retroperitoneal Free Gas

The medical or surgical history of the patient can raise suspicion of the possibility of free gas within the retroperitoneum. In most cases, however, the patient presents with a **history of severe trauma, such as a motor vehicle accident**, and retroperitoneal free gas is discovered by chance during the radiographic evaluation of the patient.

The discovery of retroperitoneal free gas is an emergency because it indicates severe injury to the retroperitoneum with possible injury to the kidney, ureters, major blood vessels, or nerves.

Radiographic Evaluation of Retroperitoneal Free Gas

Pelvic x-rays are very useful in the radiographic evaluation of a patient suspected to have free gas within the retroperitoneum. Gas might be seen near the psoas muscles. Air that is trapped and fixated near the edge of the psoas muscles is considered a specific sign for retroperitoneal free gas and not intraperitoneal gas.

Transabdominal ultrasonography can also be used to evaluate small amounts of free gas within the retroperitoneum with good sensitivity and specificity. When the risk of retroperitoneal injury is high, a pelvic computed tomography scan is of tremendous value to the treating physician. A **computed tomography scan** can exclude free gas within the retroperitoneum, injury to vital pelvic organs, and spinal injuries.

Pneumatosis Intestinalis

Background

Pneumatosis intestinalis is defined as the **presence of air within the wall of the gastrointestinal tract**. The accumulation of gas within the bowel wall can be caused by benign or life-threatening conditions. The benign causes of pneumatosis intestinalis include [asthma](#), scleroderma, and [pyloric stenosis](#). Life-threatening causes include necrotizing enterocolitis, [bowel ischemia](#), [malignant neoplasms](#), [bowel obstruction](#), and trauma. Pneumatosis intestinalis on radiography is merely an imaging finding, not a diagnosis. **The cause needs to be determined** because this has a huge impact on the treatment plan and prognosis of the patient.

Causes	Pathology
Bowel necrosis	Mucosal damage caused by lack of blood flow such as from volvulus or superior mesenteric artery/vein thrombosis
Post-endoscopy	Mucosal disruption and increased luminal pressure
COPD	Alveolar rupture with air dissecting into the mediastinum and extending to the bowel wall through the diaphragmatic hiatus

Steroids and autoimmune	Increased bowel permeability and decreased immunity in bacterial gas entering the bowel wall
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Clinical presentation of pneumatosis intestinalis

The clinical presentation depends on the cause. Patients with asthma might present with an **acute and severe exacerbation of asthma that is complicated by abdominal pain**. The incidental finding of pneumatosis intestinalis can be seen in the radiographic evaluation of the patient. On the other hand, patients with bowel ischemia or necrotizing enterocolitis are generally very sick, septic, complain of severe abdominal pain, and may be in shock. The finding of pneumatosis intestinalis in these patients is very alarming and warrants urgent surgical intervention to avoid bowel gangrene.

Radiographic evaluation of pneumatosis intestinalis



[Image](#): "Upright AP radiograph showing gas in the wall of the small bowel in the left upper quadrant indicative of pneumatosis intestinalis." by Jto410. License: [CC BY-SA 3.0](#)

Pneumatosis intestinalis might be seen on abdominal x-rays but is better visualized on computed tomography scans. A computed tomography scan is usually indicated to evaluate the extent of bowel obstruction, ischemia, or involvement in the most likely causative disease. Finding pneumatosis intestinalis adds more confidence to the diagnosis of bowel ischemia or severe infection.

Contrast-enhanced computed tomography scans are usually not needed for the initial evaluation of pneumatosis intestinalis. The most specific sign of pneumatosis intestinalis on computed tomography is radiolucency within the bowel wall. Radiolucency patterns include linear, bubble, or curvilinear gas collections. Computed tomography scans are also helpful for visualizing free fluid, soft-tissue thickening, and bowel wall edema, which indicate a life-threatening cause of pneumatosis.

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