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Spectrum of Signs of Pneumoperitoneum

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Pneumoperitoneum is caused by rupture of a hollow viscus that includes the stomach, small bowel, and large bowel, with the exception of those portions that are retroperitoneal in the duodenum and colon. The causes of pneumoperitoneum are numerous, ranging from iatrogenic and benign causes to more life-threatening conditions. In the absence of a benign cause of pneumoperitoneum, the identification of free intraperitoneal gas usually indicates the need for emergency surgery to repair a perforated bowel. The plain film is the primary diagnostic tool for detecting pneumoperitoneum: multiple signs of free intraperitoneal air can be found especially on supine abdominal radiographs. Computed tomography (CT) examination has been shown to be more sensitive than abdominal radiographs for the detection of free intraperitoneal air. It is important that the radiologist become familiar with the signs of pneumoperitoneum that can be discerned on abdominal radiographs, on CT scout view, and on CT scan.
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Introduction

Pneumoperitoneum is caused by rupture of a hollow viscus that includes the stomach, small bowel, and large bowel, with the exception of those portions that are retroperitoneal in the duodenum and colon. Perforation of the alimentary tract may result from a variety of causes. The most frequent cause of spontaneous pneumoperitoneum is perforation of a gastric or duodenal ulcer. Pneumoperitoneum may also be observed with a variety of other conditions, including recent abdominal surgery, trauma, infection, paracentesis, and pneumatosis intestinalis.[1] After laparotomy, air would usually be present for 3-7 days, gradually decreasing in volume daily.[2]

Even if the enhanced computed tomography (CT) of the abdomen and pelvis is considered the most appropriate examination for patients with fever, nonlocalized abdominal pain, and no recent surgery, plain radiography remains the most frequently requested examination performed as initial imaging procedure in the assessment of patients who present with acute abdominal pain to the emergency department.[3-5]

Upright posteroanterior chest radiography traditionally has been used for the initial examination of patients suspected of having pneumoperitoneum. Pneumoperitoneum is visualized as a translucent crescent or area below the diaphragm.[6] The upright chest radiograph can enable detection of as little as 1 mL of free air located beneath the right or left hemidiaphragm.[7] For this reason, the upright posteroanterior chest radiography is routinely included as part of the acute abdominal series.

In the emergency setting, in patients with critical illness, the supine decubitus is preferred, and radiographic examinations are performed in the supine decubitus, with anteroposterior view of the thorax and anteroposterior and lateral view of the abdomen.[8]

Multiple signs of free intraperitoneal air can be found on plain films, especially in supine abdominal radiographs, and on CT examinations. The purpose of this article is to illustrate the spectrum of signs of pneumoperitoneum that can be detected in plain radiographs, on CT scout view, and on CT scans.

Pneumoperitoneum: Causes and Clinical Presentation

There are 4 etiologic categories of pneumoperitoneum: iatrogenic, spontaneous, traumatic, and miscellaneous.[9] Iatrogenic causes comprise surgery, recent endoscopy, feeding tube

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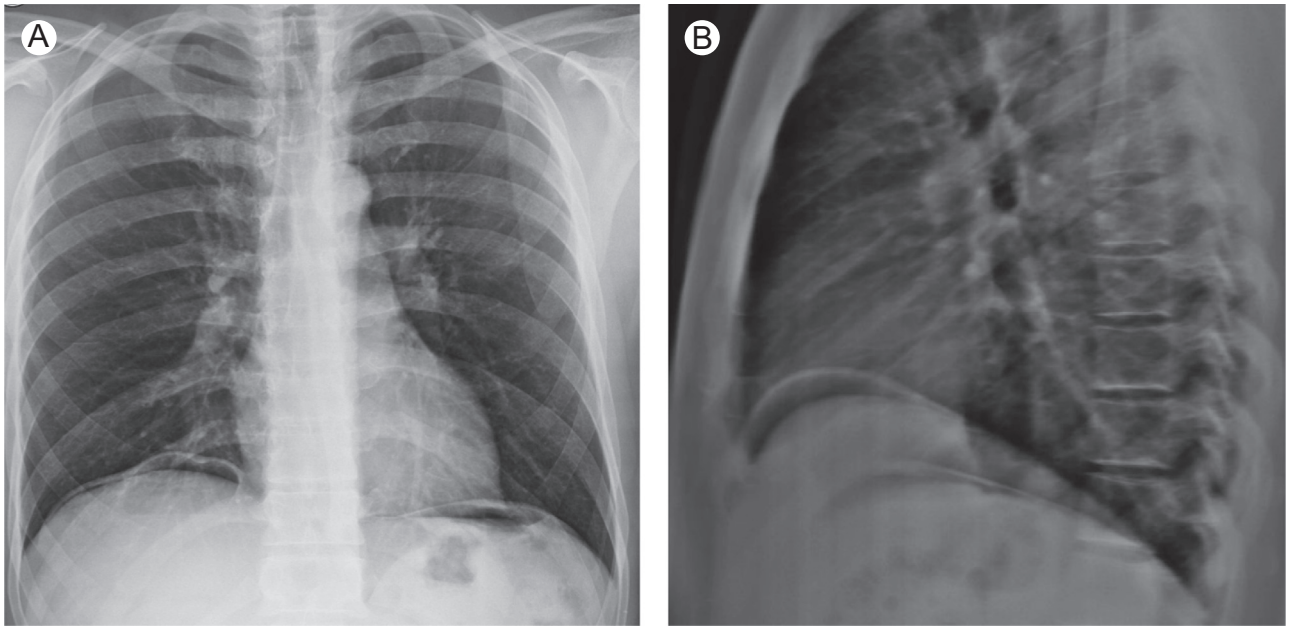

Figure 1 Upright posteroanterior (A) and lateral (B) chest radiographs showing pneumoperitoneum beneath the right and left hemidiaphragms.

placement, use of gynecologic instruments, peritoneal dialysis, and vigorous respiratory resuscitation. Spontaneous causes include peptic ulcer perforation, bowel obstruction, intestinal ischemia, toxic megacolon, and inflammatory conditions such as acute appendicitis, necrotizing enterocolitis, and tuberculosis. Traumatic causes can be blunt or penetrating, either of which can determine intestinal tract perforation. Miscellaneous causes include drugs (steroidal drugs and nonsteroidal anti-inflammatory drugs) and pneumatosis coli or intestinalis. Moreover, miscellaneous causes may be female genital tract–related causes (after coitus, orogenital sex, and even sometimes following exercise in the postpartum period).[9,10] Radiologic evaluation of causes of pneumoperitoneum should be performed with clinical information in mind, including the degree of abdominal pain, signs of peritonitis, and the presence or absence of fever and leukocytosis.[11] Patients typically present with the acute onset of abdominal pain that is persistent, progressive, and unremitting. Severity of the pain depends on the type and amount of intestinal contents released into the peritoneal cavity. Patients may have associated symptoms, including fever, nausea, and vomiting. On physical examination, a patient with intestinal tract perforation typically manifests diffuse tenderness to palpation and peritonitis.[12] Recognizing a perforation and establishing the cause and site of the perforation can yield crucial information for the surgeon.[6]

Role of Plain Radiographs and CT in the Diagnosis of Pneumoperitoneum

Conventional radiography is commonly the initial imaging examination performed in the diagnostic workup of patients who present with acute abdominal pain to the emergency department. Plain radiography can demonstrate 55%-85% of patients with pneumoperitoneum.[13] This examination is widely available, can be easily performed in admitted patients, and is used to exclude major illness such as perforated viscus, bowel obstruction, and foreign bodies ingestion.[14] Moreover, plain abdominal film is useful in the evaluation of the different

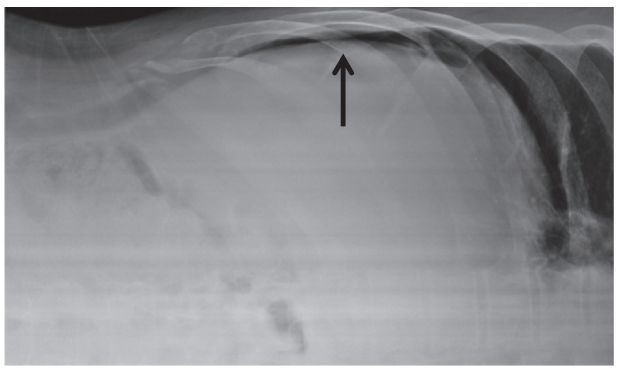

Figure 2 Left lateral decubitus film of the abdomen: evidence of pneumoperitoneum (arrow).

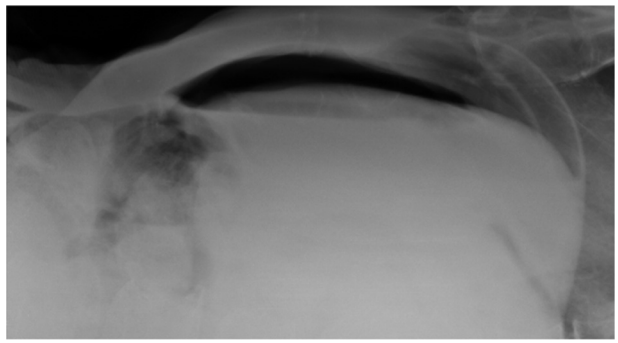

Figure 3 Cross-table lateral abdominal radiograph showing the presence of pneumoperitoneum.