Ectopic abdominopelvic gas in adults: diagnostic pearls and errors

Poster No.: C-2385
Congress: ECR 2012
Type: Educational Exhibit
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Keywords: Abdomen, Emergency, CT, Conventional radiography, Computer Applications-Detection, diagnosis, Infection, Artifacts
DOI: 10.1594/ecr2012/C-2385

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Learning objectives

The objective of this review is to differentiate the pathologic and non-pathologic causes of ectopic gas in the abdomen and pelvis, with the aim of optimizing an adequate therapeutic technique in each case whether it implies an aggressive medical and often surgical management or an expectant behaviour.
Background

The presence of gas within the peritoneum, the parenchyma of solid organs or the walls of hollow viscera may be due to a variety of pathologic or benign entities. There is a wide variety of clinical conditions which manifest radiologically by the presence of ectopic gas in the abdomen and pelvis and can represent a serious or even life-threatening condition. The initial clinical manifestation of these entities may be insidious, but rapid progression to sepsis will occur in the absence of early therapeutic intervention. Conventional X-rays and ultrasonography are the most common initial imaging modalities used to evaluate patients with abdominopelvic complaints. Computed tomography (CT) should be considered the imaging modality of choice when detection of abnormal gas is seen with the other imaging techniques, because it is highly sensitive and specific in the detection of abnormal gas and reliable in identifying the anatomic location and extent of the gas. CT is equally important in identifying benign sources of gas, because treatment (if any) varies dramatically depending on the source. The radiological depiction varies according to gas location, extent and severity. These data, together with the patient's clinical information, give us the key to reaching an accurate diagnosis.
Imaging findings OR Procedure details

CAUSES OF PATHOLOGIC ECTOPIC GAS:

• **Infection:** Tissue infection with gas-forming bacteria (or emphysematous infection) is a very important source of gas that can affect any organ in the abdomen and pelvis either as a diffuse pattern of gas in the wall or the parenchyma of the structure involved, as a well circumscribed abscess secondary to any infectious process or as presence of gas in the portomesenteric axis (usually as a secondary finding to the main infectious process). These are severe infections, most commonly seen in diabetic patients. The clinical course can be severe and life-threatening if not recognized and treated promptly.[1-3]

**Imaging findings:**
- Cases of emphysematous cholecystitis Fig. 1 on page 7, emphysematous cystitis Fig. 2 on page 7, emphysematous pyelonephritis Fig. 3 on page 8 and emphysematous pyelitis Fig. 4 on page 8 are shown.
- Abscess in the context of a perforated cholecystitis Fig. 1 on page 7.
- An infected aortic endoprosthesis is also presented. Fig. 5 on page 9

• **Necrosis:** Another source of pathologic gas is caused by infarction with liquefactive necrosis, which is usually seen as pneumatosis of the bowel wall and in the portomesenteric axis in mesenteric ischemia, obstruction of the bowel or necrotizing enterocolitis, among others. It may also be present when extensive necrosis is seen in a solid organ.
  Necrotizing fasciitis is an inflammatory infection located in the deep fascia, with secondary necrosis of the subcutaneous tissues.

**Imaging findings:**
- Mesenteric ischemia and ischemic colitis are the most common causes of pneumatosis of the bowel wall and can also present gas in the portomesenteric axis. [4,5] Fig. 6 on page 10 Fig. 7 on page 11
- Liquefactive necrosis of the spleen is seen in a patient with embolization of the splenic artery as a treatment for a severe hemolytic anemia. Fig. 8 on page 12
- Necrotizing fasciitis shows gas in the subcutaneous tissue, thickening of the affected fascia, fluid collections around the deep fascia and extension of the edema into the intermuscular septa and the muscles. [6] Fig. 9 on page 13

• **Perforation of hollow viscera:** When a hollow viscera wall ruptures, the contents of the lumen (including gas) is expelled into the peritoneum cavity. Pneumoperitoneum it’s a sign that must alert the radiologist to look for a pathologic cause such as inflammatory disease, peptic ulcer disease, bowel obstruction, bowel suture dehiscence, etc.

**Imaging findings:**
- Cases of perforated gastric ulcer Fig. 10 on page 14 and perforated mesenteric ischemia are presented. Fig. 6 on page 10
• **Fistulas:** Defined as an abnormal connection between two epithelium-lined organs or vessels that normally do not connect. When a hollow viscera is one of the implicated organs, the normally contained gas in the lumen of the viscera is also seen in the other affected organ by the fistula, for example the aorta, the biliary tree, the bladder, etc. **Imaging findings:** A bilio-enteric fistula with a secondary biliary ileus is presented as case of pneumobilia. Fig. 11 on page 15

• **Others:** There are several conditions responsible for abnormal presence of gas in the abdomen within different locations (porto-mesenteric axis, bowel wall and peritoneum cavity, that don’t imply the three already mentioned, such as: barotrauma, asthma, chronic obstructive pulmonary disease, etc. **Imaging findings:**

Barotrauma: Pneumatosis and rupture of the stomach wall due to scuba diving, with subsequent pneumoperitoneum. Fig. 12 on page 16

**CAUSES OF NON-PATHOLOGIC ECTOPICT GAS:**

• **Iatrogenic:** Atmospheric air introduced at recent instrumentation or surgery. [8] **Imaging findings:**
  o Pneumoperitoneum may be found in recently operated patients, especially after laparoscopy, without implying a pathologic intraabdominal process. Fig. 13 on page 17
  
  o Post-surgical normal gas in an aortic endoprosthesis. Fig. 14 on page 18
  
  o Gastric and bowel dilatation (e.g upper and lower endoscopic procedures, enemas) may produce pneumatosis of the bowel wall;
  
  o Catheterization or drainages may introduce gas in the bladder, blood vessels, solid organs, etc; Fig. 15 on page 18 Fig. 16 on page 19
  
  o Biliary-enteric surgical anastomosis or drainage, produce iatrogenic pneumobilia. Fig. 17 on page 20

• **Spontaneous:**
  o Pneumatosis coli cistoides: Consists of air-filled cysts of various sizes in the submucosa and subserosa of the colon. It can be focal or diffuse and it is usually asymptomatic but it can cause pneumoperitoneum as well as intermittent or persistent abdominal pain. **Imaging findings:** Cases of pneumatosis coli cistoides as an incidental finding and a perforated one are shown. Fig. 18 on page 20
  
  o Cholelithiasis "Mercedes Benz sign": "Mercedes Benz" sign is a triradiate collection of nitrogen gas in gallbladder stones. Crevices are created by shrinkage of cholesterol crystals in the stone. Radiolucent fissures usually widest centrally radiating like points of star. It should not be confused with pathologic gas in the gallbladder, like in the case of an emphysematous cholecystitis. Fig. 19 on page 21
Fibrous degeneration of intervertebral disc: Within time, the intervertebral disc degenerates and produces nitrous oxide which gives a gas appearance in diagnostic imaging. Imaging findings: A case of a vertebral fracture with ruptured intervertebral disc. Nitrous oxide is expelled and has migrated to the spinal channel and other adjacent structures as the retroperitoneum. This finding may lead to believe that there might be an abdominal underlying pathologic cause. Fig. 20 on page 22
Fig. 1: A. Conventional abdominal X rays shows linear pattern of gas within right middle part of the abdomen (arrows). B. CT scan, portal phase axial view, shows gas in the gallbladder wall (long arrow), with inflammatory changes in the surrounding fat and a hepatic subcapsular abscess secondary to perforated emphysematous cholecystitis.

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**Fig. 2:** Emphysematous cystitis. A. Conventional X rays shows a linear gas pattern with a round shape within the pelvis (arrows). B. Ultrasonography shows multiple bright echogenic foci (arrows) with distal reverberation artifacts. C. CT scan shows gas in the bladder wall.

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**Fig. 3:** Emphysematous pyelonephritis. CT scan shows an enlarged right kidney (thin arrows) with inflammation of the surrounding fat. Note the gas bubbles in the dilated calyceal system (thick arrow).

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Fig. 4: CT scan MPR coronal view shows gas within the left pelvis (arrow) and ureter. Note a high attenuating stone in the calyceal system.

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**Fig. 5:** Infected aortic endoprosthesis. CT scan, axial view shows inflammatory changes in the fat surrounding the endoprosthesis and gas bubbles within.

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**Fig. 6:** Perforated mesenteric ischemia. CT scan shows dilated bowel loops with pneumatosis of the wall (short arrows) and pneumoperitoneum (long arrows).

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Fig. 7: Intrahepatic portal gas showing the typical peripheral distribution. Also note portosplenic gas in a patient with splenic infarcts (arrows) in the context of sepsis.

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**Fig. 8:** Contrast-enhanced axial CT scan. Enlarged, liquefied spleen contains an air-fluid level (solid arrows) and displaces stomach and pancreas to right of midline. Note minimal contrast enhancement of splenic capsule (open arrows). An incidental lipoma is present within anterior, inferior aspect of chest wall on right side (arrowhead).

Fig. 9: Necrotizing fasciitis. CT scan centered in the right pelvis (A) and right lower limb (B) show gas bubbles within the iliopsoas muscle (arrows in A), extending downwards to the anterior compartment of the lower limb.

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Fig. 10: Perforated pyloric ulcer. Fat stranding adjacent to the pylorus with extraluminal gas and pneumoperitoneum.

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**Fig. 11:** Biliary ileus. Contrast-enhanced CT scan shows pneumobilia (arrow in A), a bilio-enteric fistula (arrow in B) and dilated bowel loops (arrows in C). D. Hyperattenuating round image within a jejunal bowel loop, which surgery proved to be a large gallstone.

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**Fig. 12:** Barotrauma: enhanced-CT scan shows pneumatosis and rupture of the stomach wall due to scuba diving, with subsequent pneumoperitoneum.

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Fig. 13: A. Pneumoperitoneum as a non pathologic finding. B. Recent surgery (Whipple procedure) was practiced in this patient.

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Fig. 14: CT scan arterial phase shows a gas bubble within the aortic endoprosthesis without any inflammatory changes associated.

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**Fig. 15:** Contrast enhanced CT shows pneumobilia associated to a biliary drainage (arrow), in a patient with pancreatic adenocarcinoma.

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**Fig. 16:** CT scan axial view shows gas bubbles within the bladder secondary to catheterization.

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**Fig. 17:** CT scan shows pneumobilia (arrow in A) in a patient with pancreatoduodenectomy and hepaticojejunostomy (arrow in B). This surgical fistula may produce pneumobilia.

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**Fig. 18:** CT scan axial view. A. Note the small air-filled cysts in the wall of the colon in an asymptomatic patient. B. Another patient with pnumoperitoneum secondary to rupture of the cysts.

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**Fig. 19:** Axial CT demonstrating the Mercedes-Benz sign, a radial pattern of gas fissuring within gallstones.
**Fig. 20:** CT scan, MPR sagital view demonstrates a vertebral compression fracture with extravasation of nitrous oxide from the intervertebral disc to the retroperitoneum. There was not an intraabdominal cause for the retroneumoperitoneum.
Conclusion

The radiologist must recognize with prompt, accurate interpretation of situations in which ectopic gas indicates a serious disease and distinguish them from situations with no pathological significance that require no intervention, and should be familiar with the specific characteristics of each entity.
References


