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Imaging Patients With Alimentary Tract Perforation: Literature Review

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Alimentary tract perforation is a frequent emergency condition. Imaging plays an important role to make an accurate diagnosis, defining the presence, the level, and the cause of the perforation, essential information to enable the most correct therapeutic choice. Plain radiography is generally performed as the first choice. In case of a clinically suspected bowel perforation, not detected on x-ray imaging, the contribution of computed tomography is essential. Magnetic resonance is not yet widely used in diagnostic workup of patients with acute abdominal pain, but it can be useful in the differential diagnosis of acute abdomen in specific patients (pregnancy and pediatric patients).
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Introduction

Alimentary tract perforation is one of the most frequent reasons for admittance to emergency department. Imaging plays an important role, in conjunction with clinical information, to make a quick and accurate diagnosis, defining the presence, the level, and the cause of the perforation, essential information to enable the most correct therapeutic choice, thus improving patient outcome.[1] Bowel perforation can be caused by trauma (blunt or penetrating trauma, foreign body ingestion, iatrogenic injury, or endoscopic procedures) or by nontraumatic inflammatory (peptic ulcers, enteritis, or Crohn's disease), ischemic (mesenteric infarction, volvulus, intussusception, or vasculitis), and neoplastic conditions.[2-8] Symptoms are variable and nonspecific, so imaging plays an important role for the diagnosis of alimentary tract perforation.[9] In the diagnostic management of these patients, plain radiography is generally performed as the first choice. In case of a clinically suspected bowel perforation, not detected on x-ray imaging, the contribution of computed tomography (CT) is essential; in fact it has a sensitivity of 92% in detecting perforations in the whole gastrointestinal (GI) tract.[9-12] Magnetic resonance (MR) is not yet widely used in diagnostic workup of patients with acute abdominal pain, but it can be useful in the differential diagnosis of acute abdomen in specific patients (pregnancy and pediatric patients).[13]

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Clinical Features

From a clinical point of view, clinical symptoms are variable because they are related to the cause and the site of the perforation. Neverthless, alimentary tract perforation is generally characterized by the appearance of an acute abdomen.[14]

In the beginning, pain is often localized in the suggested site of origin; it may move to a different site by the time the patient is examined and, if not promptly treated, culminate in diffuse and poorly localized abdominal pain.

Nausea, vomiting, fever, localized abscess formation, inflammatory mass, fistulas, and GI tract hemorrhage could be present. On the contrary, rare complications are septicemia, portal pyemia or pyogenic abscess, enterovascular fistulas, and even endocarditis.[15-17]

In some cases the clinical features may be nonspecific, for example in patients with covered perforation, those receiving treatment with steroid drugs, or immunocompromised patients.[14]

Conventional Radiography

Conventional radiography may be performed in the setting of acute abdominal pain. Abdominal radiography, however, has a limited role in the evaluation of abdominal pain in adults.[15,18] Although it has been shown to have high sensitivity (90%) for

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detecting intra-abdominal foreign bodies and moderate sensitivity for detecting bowel obstruction (49%), its low sensitivity for sources of abdominal pain and fever or abscess limit its role in this setting.[19-23] For these reasons it remains the most frequently requested examination performed as initial imaging in the assessment of patients who present with acute abdominal pain and clinical suspicion of bowel obstruction to the emergency department. It is widely available and cheap, and it can be easily performed.[13,24-27]

The diagnosis of bowel perforation is suggested by the detection of free intraperitoneal gas on the plain x-ray imaging. Some authors report that specificity of plain x-ray imaging for pneumoperitoneum ranges from 50%-70%[14,15] and other authors from 53%-89.2%,[28] but the site of perforation is almost never elucidated. Furthermore, in up to 49% of patients, pneumoperitoneum or retroperitoneum could not be detected.[29]

Esophageal perforation's findings can be detected, on posteroanterior and lateral plain chest radiographs, as indirect signs and include pleural effusion, pneumomediastinum, subcutaneous emphysema, hydrothorax, pneumothorax, and collapse of the lung.

However, if the patient can swallow, a chest radiograph with a water-soluble contrast medium could be executed, revealing a contrast leak in most cases of esophageal perforation. Water-soluble contrast should be used instead of barium contrast to prevent barium-related inflammation of the mediastinum. If the initial contrast swallowing study result is negative and the clinical suspicion remains, imaging should be repeated after 4-6 hours.[29,30]

Plain abdominal radiograph is generally performed in upright and supine decubitus. In patients with critical illness, the supine decubitus is preferred, with anteroposterior and lateral views of the abdomen and anteroposterior view of the thorax.[27] Supine abdominal radiograph allows detection of moderate or large amounts of free intraperitoneal air. On the contrary, it is insensitive in detecting small amounts of free intraperitoneal air, which could be interposed between the free edge of the liver and the lateral wall of the peritoneal cavity and may be detected by upright chest films or left lateral decubitus abdominal films or both. In fact, upright posteroanterior chest radiograph is considered to be the most sensitive plain film for detecting pneumoperitoneum, and it may show as little as 1 mL of free intraperitoneal air when meticulous radiographic technique is used upright; however, because the x-ray beam is centered on the middle part of the abdomen, and the exposure is high, small amounts of free air can be obscured. Left lateral decubitus radiograph of the abdomen can show small amounts of free air if the heavy exposure does not compromise the detection. Upright posteroanterior chest radiograph is very helpful because central x-ray beam penetrates air in the superior portion of the subdiaphragmatic recess along its long axis and usually does not burn out small amount of free air. The upright lateral chest radiograph is more sensitive than the posteroanterior chest radiograph in detecting small amounts of pneumoperitoneum as the long axis of x-ray beam can show small air collection that may remain trapped anterior to the liver.[31]

Direct findings of perforation and intraperitoneal free air are, on the upright thoracic film, the air in the subdiaphragmatic regions and, on the supine abdominal films, the outlining of various peritoneal reflections between the mesenteric folds.

Indirect sign of perforation could be detected such as translucent triangle, lucent liver, perihepatic gas collections, Rigler's sign, cupola sign, and football and cap of Doge signs. If bowel perforation is detected on x-ray examination, further imaging, before laparotomy, is useful to better evaluate the site and the etiology of perforation.[24,32,33]

Ultrasound

Ultrasound (US) imaging could be executed as the first examination in emergency and is particularly indicated in young patients and pregnant woman, patients in whom radiation should be avoided.[34] Nevertheless some authors assess that US imaging is more sensitive than plain radiography in the diagnosis of pneumoperitoneum with a sensitivity of 92% (vs 78% of plain abdominal film) and a negative predictive value of 39% (vs 20%), and the site of perforation is difficult to determine.[13,14] On the contrary other authors detected a lower sensitivity for the US (76% vs 92%).[35] Linear array transducers (10-12 MHz) could be preferred because they are more sensitive than convex transducers (2-5 MHz) in the detection of intraperitoneal free air owing to their size, shape, and resolution. US imaging findings in case of free intraperitoneal air result from scattering of the US waves at the interface of soft tissue and air, which is accompanied by reverberation of the waves between the transducer and the air. Consequently there is an increased echogenicity of a peritoneal stripe associated with multiple reflection artifacts and characteristic comet-tail appearance that can be changed by changing the patient's position.[36]

Indirect signs of bowel wall perforation detectable by US imaging are presented by intraperitoneal free fluid or reduced intestinal peristalsis.[37-40]

US shortcomings are operator dependence, poor cooperation of some patients due to the abdominal pain, and patients with obesity or subcutaneous emphysema. Furthermore, US has low sensitivity in the detection of retropneumoperitoneum revealing the presence of air around the duodenum and the head of the pancreas, especially ventral to the great abdominal vessel leading to the picture of "vanishing" vessels.[41-48]

Computed Tomography

In general, CT is the most diffuse modality in evaluating nonpregnant patients with abdominal pain. CT has a very high sensitivity in the diagnosis of GI tract perforation and in the determination of the site of perforation, with an accuracy that may increase to 86%.

Moreover, the recent introduction of multiple detector computed tomography (MDCT) has allowed high-speed acquisition, thin slice collimation, and reformatting of images in any plane with high spatial resolution, making this technique particularly suitable for the assessment of abdominal

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