

Diagnostic value of pneumoperitoneum on plain abdominal film

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Background. *Pneumoperitoneum is the presence of air outside the gut lumen as the hallmark of alimentary tract perforation. It can be spontaneous or traumatic in origin. The most frequent cause of spontaneous pneumoperitoneum is the perforation of gastric or duodenal ulcer and the aim of the study was to assess the diagnostic value of pneumoperitoneum on plain abdominal film.*

Patients and methods. *This is a retrospective study based on the diagnostic value of pneumoperitoneum on plain abdominal film, with the patient in upright, supine and sometimes left lateral decubitus position. The study included 79 patients who were admitted to our hospital during a 2-year period of time (1998-1999) and operated on for perforated gastroduodenal ulcer.*

Results. *Ten (12.66 %) of 79 patients underwent operation without radiological procedure. Sixty-nine (87.34 %) patients were examined radiographically and 53 (76.81 %) of them had signs of pneumoperitoneum initially on the plain film.*

Conclusions. *The most common cause of pneumoperitoneum was perforated duodenal ulcer in elderly male patients. The most frequent sign of pneumoperitoneum was the crescent shaped free air beneath the diaphragm.*

Key words: peptic ulcer perforation; pneumoperitoneum – radiography

Introduction

Pneumoperitoneum is the presence of air outside the gut lumen as the hallmark of alimentary tract perforation on plain film.¹ It can be spontaneous or traumatic in origin. The most

frequent cause of spontaneous pneumoperitoneum is the perforation of gastric or duodenal ulcer² and that is the reason why we included these patients in our study. The aim of the study was to assess the diagnostic value of pneumoperitoneum on plain abdominal film.

The traditional sign of pneumoperitoneum is the crescent shaped free air beneath the diaphragm on erect chest seen on abdominal plain film. In this position, it is possible to detect as little as 1 to 2 ml of free air.^{1,3}

The signs of pneumoperitoneum on supine abdominal film are:

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- “the dog’s cap sign” – air in Morison’s pouch,⁴
- free air occurring subhepatically inferior and anterior to the liver as a linear collection of air parallel to the lower edge of liver,⁵
- the falciform ligament sign as a vertically oriented soft-tissue band parallel to the right border of the spine in the region of the thoracolumbar juncture,⁶
- “Wind’s sign” or “lucent liver sign”,¹
- “the dome sign” – free air trapped under the middle part of the diaphragm,⁷
- “the double wall sign” or Riegler sign – when there is air in the peritoneal cavity and in the bowel lumen, the mucosal and serosal surfaces are simultaneously outlined,¹
- “the sign of triangle” – the air between the loops of bowel,⁷
- “the football sign” – the air-distended peritoneum beneath the anterior abdominal wall,¹
- and finally, rare signs of pneumoperitoneum, like visible lateral umbilical ligaments or urachus, free air in an inguinal or femoral hernia sac and pneumoscrotum.⁸⁻¹⁰

Some of the described signs are visible on Figures 1 and 2.



Figure 1. The sign of pneumoperitoneum on erect chest film – crescent shaped free air beneath the diaphragm (arrows).



Figure 2. The signs of pneumoperitoneum on supine plain abdominal film (arrows): “Wind’s sign” or “lucent liver sign”, free air subhepatic as a linear parallel collection, the falciform ligament sign, “the dome sign”.

Pneumoperitoneum may be a solitary plain film finding or it may coexist with pneumomediastinum or pneumoretroperitoneum, or both.^{1,11,12}

It should be emphasized that there is a condition known as “benign” or “internistial” pneumoperitoneum – spontaneous pneumoperitoneum without peritonitis which usually has no clinical signs¹³ and can be diagnosed only by plain abdominal film.^{14,15} “Benign pneumoperitoneum” was described with gastric distension,^{14,15} jejunal diverticulosis,¹⁶ pneumatosis intestinalis¹⁷ and scleroderma,^{18,19} and immunosuppressive therapy.^{11,15} Such patients are treated by conservative therapy and very rare by surgical operation.^{20,21}

The other conditions which can mimic the signs of pneumoperitoneum are: interposition of the colon or Chilaiditi syndrome, fat depositions, artifacts, intraabdominal abscess, intraperitoneal or internal hernia and volvulus, especially of the mobile caecum.

Pneumoperitoneum is usually diagnosed on plain abdominal film with the patient in upright, supine or left lateral position. Also, it

can be diagnosed on erect chest film or using ultrasound (US),²² or computed tomography (CT).²³

Patients and methods

During a 2-year period of time (1998-1999), 79 patients were admitted to our hospital and operated on for perforated gastroduodenal ulcers.

The abdominal plain films were taken in 69 (87.34%) patients preoperatively, with the patients in upright (62 cases), supine (3 cases) and left lateral decubitus position (4 cases)).

In 5 (7.25%) of 16 patients with suspected ulcer perforation but with normal findings on plain film, the additional contrast-study under diascopic control was performed.

We divided our patients in several groups, according to their age, sex, type of ulcers and signs of pneumoperitoneum.

Results

We reviewed retrospectively the hospital data of 79 patients who were admitted to our hospital in the 2-year period of time from 1998 to 1999 and operated on for perforated gastroduodenal ulcer. The data are given in Table 1.

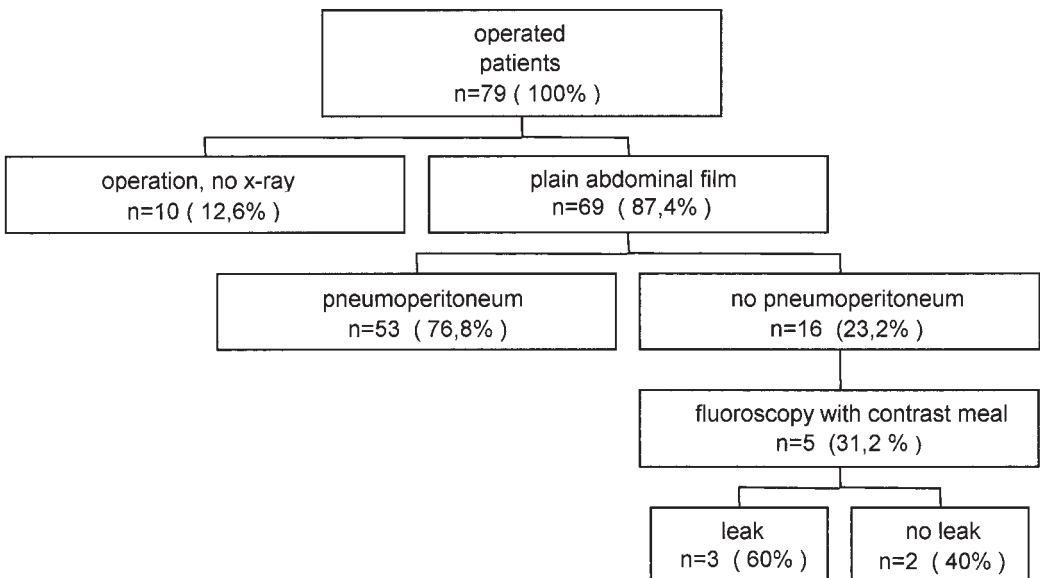
Ten (12.66%) of them underwent an operation without radiological procedure.

We noticed that men had higher incidence of both ulcers than women, especially duodenal (M:F = 55:24). Also, it was interesting to note that women had equal incidence of both ulcers (Figure 3).

The distribution of pathologic findings, according to the age of patients is shown by linear chart (Figure 4). Apparently, most of the patients were 40 to 60 years old.

The most frequent sign of pneumoperitoneum was the crescent shaped free air beneath the diaphragm (49 cases or 92%), whereas other known signs of pneumoperitoneum were mentioned and identified very rarely (Figure 5).

Table 1. Operated patients because of perforated gastroduodenal ulcers and radiologic exams performed in emergency department



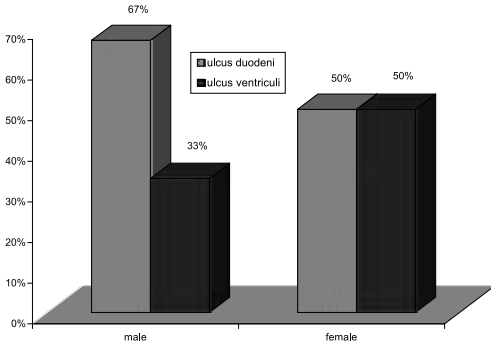


Figure 3. Type of perforated ulcer according to the sex.

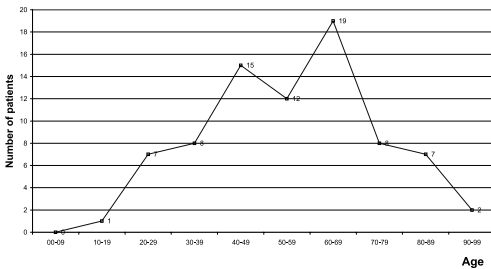


Figure 4. The age incidence of patients with perforated ulcers shown by chart.

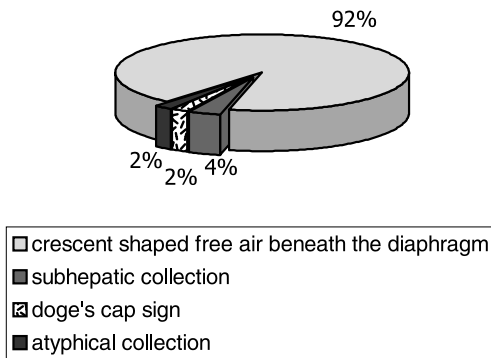


Figure 5. Identified signs of pneumoperitoneum on plain abdominal films graphically.

The other signs were: subhepatic collection (2 cases or 4%), "doge's cap sign" or free air in Morison's pouch (1 case or 2%) and atypical collection of intraperitoneal air between the bowel loops (1 case or 2%).

Discussion

Most of radiologists describe the findings of pneumoperitoneum as positive in 60-85% of cases.^{13,24-26} So, our results are in correlation with their findings.

Also, we have to emphasize that abdominal plain films were analyzed by different radiologists in Emergency Department. Maybe, these results would be better if the plain films were analyzed by radiologists who are subspecialists in gastroenterology. The most frequent sign which we found was crescent shaped free air beneath the diaphragm. We think that the reason why it is so, is probably the fact that most of radiologists (ours and others) prefer that, whenever is possible, the abdominal plain film are made with the patients in upright position. It is the least dependent part of peritoneal cavity and free air can be easily detected. We believe that, if radiologists were able to recognize the signs of pneumoperitoneum, the position of patient would not matter at all. In that case, other signs of pneumoperitoneum, not only the crescent shaped free air beneath the diaphragm (Figure 5), would be recognized and identified on the plain abdominal films.

Since the policy of most surgeons is to recommend surgery in any patient with abdominal symptoms and suspected pneumoperitoneum, it is evident that the plain abdominal films can give valuable information.²⁴

Should we perform the plain abdominal film in all patients?

The "board - like" rigidity which generally indicates an abdominal catastrophe needing laparotomy can be found in 83-93% of these patients.¹⁰ It means that a substantial number of patients with perforated ulcer are referred to roentgen examination even though laparotomy is indicated whatever the radiologic findings. Some proportion of patients with normal plain films operated on directly and without further investigations may support the impression that the plain films were taken in many patients "just to be sure".²⁴

Very often, less experienced surgeons work in emergency departments and they need a plain abdominal films as a diagnostic support.

One argument that may support the practice of obtaining X-ray films in nearly all patients is related to the fact that the perforation occurs in elderly patients with often atypical clinical findings.^{25,27,28}

Our investigation also confirms this (Figure 4).

The influence of age on a low proportion of pneumoperitoneum in young patients is difficult to explain. Seely²⁹ and Taylor³⁰ have suggested that the acute ulcers, which may be more common in young patients, can be expected to heal spontaneously.

Even in centers with unlimited resources, plain films supplemented by gastrointestinal contrast studies as needed, remain the modern standard for evaluation of patients who have suspected gastrointestinal perforation.

These widely available, easy to perform, and relatively inexpensive procedures are relatively sensitive and specific for evaluation of this problem. It is, therefore, crucial for radiologists to be familiar with the often subtle signs of gastrointestinal perforation on plain abdominal films.

Skills of plain film interpretation should not be permitted to erode in the environment of newer technologies.³¹

Although newer technologies like US²² and CT²³ give possibility for detection of pneumoperitoneum, they are not routinely used in emergency departments so that the signs of pneumoperitoneum detected by them are significant, but usually an incidental finding.

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