Ultrasound versus Plain Radiography in the Detection of Pneumoperitoneum

Ibtesam K.S. Al-Shadydy

Abstract:

Objective: To compare plain radiography with ultrasonography in the detection of pneumoperitoneum.

Methods: A total of 72 patients with suspected hollow viscus perforation were studied. All patients had ultrasonography, upright chest radiography and left lateral decubitus abdominal radiography examination. The sensitivity, specificity, positive and negative predictive value, and accuracy of upright chest and abdominal radiography were compared with that of abdominal ultrasonography.

Results: Sixty eight patients underwent laparotomy; 66 patients had hollow viscus perforations, (if we include four patients had perforated appendicitis) and two had acute cholecystitis. In the diagnosis of pneumoperitoneum, ultrasonography had improved sensitivity (90 versus 75 percent), negative predictive value (36 versus 18 percent), and accuracy (88 versus 74 percent), and similar specificity (both 50 percent), and positive predictive value (95 versus 93 percent) compared with plain radiography.

Conclusion: Ultrasonography is more sensitive than plain radiography in the diagnosis of pneumoperitoneum.

Key words: Ultrasonography, Radiography, Pneumoperitoneum.

Introduction:

Pneumoperitoneum results most commonly from a perforated hollow viscus. Plain radiography of the chest is a standard method for the detection of pneumoperitoneum [1,2], and this can be helpful in 55-85 percent of patients with hollow organ perforation[3,4], many patients with an acute abdomen or trauma are too sick to stand for erect chest radiographic examination[5,6]. Alternatively, left lateral decubitus radiography of the abdomen can be used. Although computed tomography (CT) is superior to erect chest radiography in demonstrating free intra-peritoneal air, however CT is expensive and generates more radiation than plain radiography [7].

Ultrasonography has emerged as an alternative initial diagnostic procedure in patients with an acute abdomen [8-10].

The aim of this study was to compare ultrasonography with plain radiography in the detection of pneumoperitoneum.

Patients & Methods:

Between March 1998 and August 2000, 72 patients with suspected hollow viscus perforation were admitted to the surgical department in Al-Kindy teaching hospital. There were 48 males and 24 females, mean age 50 years, range (20-75 years). After detailed history and physical examination, erect chest X-ray was performed. A left lateral decubitus abdominal film was taken if the chest radiograph failed to reveal free sub-phrenic air. After complete radiographic examination, the patient was sent for ultrasound of the abdomen.

Abdominal ultrasonography was performed over the epigastric area (supine position) followed by the highest point of the right hypochondrium (left lateral position). The results of the ultrasonography were classified as either positive or normal. Ultrasonographic evidence of pneumoperitoneum was sought as echogenic lines or spots [11].

The decision to operate was based on either the presence of peritonitis depending on clinical examination, or the presence of pneumoperitoneum on either ultrasonography or plain radiography. Patients without free air were observed in hospital, additional pan- endoscopy or CT was performed to search for the diagnosis. Operative findings related to ultrasonography or radiography was recorded. The sensitivity, specificity, positive and negative predictive value, the accuracy of ultrasonography were recorded and compared with those obtained from plain radiography.

Results:

Ultrasonography was performed in all 72-patients. The ultrasonographic findings are shown in *table 1*. There were 60-patients with the ultrasonographic finding of free air, 12-patients had no free air (4-normal scan, and 8-patients with abnormal scan but no free air).

Among the 68-patients who had surgery (depending on radiological, ultrasound, and CT-finding), 60 patients were thought to have hollow viscus perforation and eight-patients to have peritonitis. A total of 62 proved to have hollow organ perforation at laparotomy (table2), for-patients had perforated appendicitis and two patients with acute cholecystitis.

Table 1. Findings of abdominal ultrasonography in 72-patients with acute abdominal pain.

Finding of abdominal u/s	No. of patients
1. Abnormal scan result	68
*** Pneumoperitoneum**	60
*** Fluid accumulation**	
- subhepatic	54
- pelvic	30
*** Small bowel dilatation**	45
2. Normal scan	4

Table 2. Intra-operative findings of 68-patients who underwent laparotomy for acute abdominal pain.

Intraoperative findings	No. of patients
Perforated duodenal ulcer	33
Perforated gastric ulcer	15
Colonic perforation	8
Intestinal perforation	6
Perforated appendicitis	4
Acute cholecystitis	2
Total	68

Oesophago-gastroduodenoscopy on 4-patients with normal scanning and acute abdominal pain (no laparotomy) revealed peptic ulceration without perforation in three patients.

Free air was detected by upright chest radiography in 48-patients, and 36 of these were found to have hollow organ perforation at operation. A further 24 patients underwent additional left lateral decubitus abdominal radiography, six were diagnosed with pneumoperitoneum, but only five patients were found to have hollow organ perforation (table 3).

The comparison between ultrasonography with plain radio-graphy in the detection of pneumoperitoneum is shown in table 4.

Table 3: Summary of the total No. of patients submitted for plain radiography, ultrasonography and the results on laparotomy.

Method of exam.	Total No. of patients submitted	+ve free air detection	Abnormal scan with no free air	Hollow viscus perforat. On lap.
Ultrasound	72	60	--	66(*)
Scanning	12	--	8	
Upright chest radiography	72	48 } 54	--	36 } 41
Lateral decubitus abdominal radiography	24	6	--	5

* Including 4-patient with perforated appendicitis

Table 4: The comparison between ultrasonography and plain radiography in the detection of pneumoperitoneum.

	Ultrsonography	Plain radiography
Sensitivity	90%	75%
-ve predictive value	36%	18%
Accuracy	88%	74%
Specificity	50%	50%
+ve predictive value	95%	93%

Discussion:

Hollow viscus perforation is one of the most common surgical emergencies. The diagnosis of hollow organ perforation is usually based on the presence of free intraperitoneal air on chest or abdominal radiography. In comparison with other study, Woodring et al., find that free air is missed on upright posteroanterior chest radiographs in 20-62 percent[7], which is in this study is about 34 percent. Adding a left lateral decubitus film improves the sensitivity of the examination: in the present study we are able to detect 6-patients with free intraperitoneal air which are not diagnosed by upright chest radiography.

It is well known that CT is the most sensitive imaging test for the detection of free intraperitoneal air [12-15]. The success rate is between 83 and 100 percent [12, 13]; however CT is more expensive and generates more radiation than plain radiography, so it is not used as an essential tool in the diagnosis of pneumoperitoneum.

In comparison with the study done by Catalano et al., ultrasonography can detect 76-90 percent of patients with pneumoperitoneum [16]. Although in this study a small number of patients were included, we demonstrate that ultrasonography is a useful alternative imaging modality for the detection of pneumoperitoneum and we are able to detect about 80 percent of patients with pneumoperitoneum.

The amount of free air produced after perforation of the lower gastrointestinal tract was usually large and both plain radiography and ultrasonography had similar accuracy in the detection of pneumoperitoneum. The amount of free air from the upper gastrointestinal tract was usually lower, and this study found that ultrasonography was superior to plain radiography in this setting. In the present study two false-positive ultrasonographic examinations resulted from the finding of abnormal images on either the right hypochondrial or the epigastric scan. To prevent the echo pattern visible in the pleurodiaphragmatic recess from being misinterpreted for free air, modification of the patient position from supine to left lateral during the examination is essential because it permits confirmation of the origin of the interference echopattern [17].

Ultrasonography has the additional advantage of detecting other findings associated with pneumoperitoneum that were not found on the plain radiographs.

In **conclusion** ultrasonography is more sensitive and accurate in the detection of pneumoperitoneum than plain radiography.

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References:

1-Markowitz SK, Ziter FMH Jr. The Lateral chest film and pneumoperitoneum. *Ann Emerg Med* 1986; 15: 425-7.

2-Mller RE, Nelson SW. The Roentgenological demonstration of tiny amounts of free intraperitoneal gas: experimental and clinical studies. *Am J Roentgenal Radium Tber Nucl Med* 1971; 112: 574-85.

3-Roh JJ, Thompson JS, Harned RK, Hodgson PE: Value of pneumoperitoneum in the diagnosis of visceral perforation. *Am J Surg* 1983; 146: 830-3.

4-Maull KI, Reath DB. Pneumogastrography in the diagnosis of perforated peptic ulcer. *Am J Surg* 1984; 148: 340-5.

5-Levine MS, Scheiner JD, Rubesin SE, Laufer, Herlinger H. Diagnosis of pneumoperitoneum on supine abdominal radiographs. *AJR Am J Roentgenol* 1991; 156: 731-5.

6-Shaffer HAJr. Perforation and Obstruction of the gastrointestinal tract. Assessment by conventional radiology. *Radial Clin North Am* 1992; 30: 405-26.

7-Woodring JH, Heiser MJ. Detection of pneumoperitoneum on chest radiographs. Comparison of upright lateral and posteroanterior projections. *Am J Roentgenol* 1995; 165: 45-7.

8-Chen SC, Chen KM, Wang SM, Chang KJ. Abdominal Sonography screening of clinically diagnosed or suspected appendicitis before surgery. *World J Surg* 1998; 22: 449-52.

9-Ogata M, Matear JR, Condon RE. Prospective evaluation of abdominal sonography for diagnosis of bowel obstruction. *Ann Surg* 1996; 223: 237-41.

10-Romano WM. Platt JF. Ultrasound of the abdomen. *Crit Care Clin* 1994; 10: 297-319.

11-Pattison P, Jeffrey RS, Mindelzum RE, Sommer FG. Sonography of intra-abdominal gas collection. *Am J Roentgenol* 1997; 169: 1559-64.

12-Stapakis JC; Thickman D. Diagnosis of pneumoperitoneum: abdominal CT vs. upright chest film . *J Compute Assist Tomogram* 1994; 18: 439-42.

13-Lee FT Jar, Leahy-Gross KM, Hammond TG, Woken MJ, Zimmerman SW. Pneumoperitoneum in peritoneal dialysis patients. Significance of diagnosis by CT. *J Comput Assist Tomogr* 1994; 18: 439-42.

14-Kane NM, Francis IR, Burney RE, Wheathey MJ. Traumatic pneumoperitoneum. Implications of computed tomography diagnosis. *Invest Radial* 1991; 26: 574-8.

15-Mindelzun RE, Jeffray RB. Unenhanced helical CT for evaluating acute abdominal pain: A little more cost, a lat more information. *Radiology* 1997; 205: 43-5.

16-Catalano O, Grassi R, Rotondo A. Abdominal free air ultrasonographic assessment. *Radio Med* 1994; 87: 632-5.

17-Mindelzum RE. Abdominal gas collection. In: McCort JJ, ed. *Abnormal Radiology*. Ballimore, Maryland: Williams and Wilkins, 1981: 181-225.

Baghdad Univ. Al-Kindy Medical College Dept of Surgery