

PNEUMOPERITONEUM DIAGNOSED USING ULTRASONOGRAPHY A NARRATIVE REVIEW OF THE LITERATURE

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ABSTRACT:

ULTRASOUND IS COMMONLY USED AS AN INITIAL EVALUATION OF THE PATIENTS WITH ACUTE ABDOMEN TO IDENTIFY THE CAUSE AS FAST AS POSSIBLE. THE TYPICAL IMAGE OF PNEUMOPERITONEUM IS FORMED BY HIGH AMPLITUDE LINEAR ECHOES WITH DISTAL ARTIFACTUAL REVERBERATION ECHOES. ABDOMINAL SONOGRAPHY IS ESSENTIAL IN A RAPID DIAGNOSIS OF THE PNEUMOPERITONEUM. THE STUDIES CONDUCTED SO FAR SHOWED IN SOME

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CASES THE SUPERIORITY OF THE METHOD, AND IN ALL CASES NO INFERIORITY. SONOGRAPHIC SIGNS OF PNEUMOPERITONEUM SHOULD BE INCLUDED IN EMERGENCY PROTOCOLS SUCH AS FAST AND RUSH.

KEYWORDS: ULTRASONOGRAPHY, PNEUMOPERITONEUM, DIAGNOSE, ACUTE ABDOMEN, EMERGENCY

INTRODUCTION

Pneumoperitoneum stands for the presence of air into the peritoneal cavity and its most common cause is the perforation of a hollow abdominal viscus such as a perforated ulcer or a perforation of any part of the bowel. Other causes may include malignancy of some level of the bowel, trauma, diverticulitis, appendicitis, bowel ischemia. A pneumoperitoneum appears frequently after abdominal surgery and may persist from 24 hours to 6 days¹⁰.

The pneumoperitoneum may be diagnosed using conventional radiology, ultrasonography or computered tomography. There are some signs that indicate the presence of the pneumoperitoneum at the radiological examination such as Rigler's sign (visualization of the both sides of the bowel wall), the faciform ligament sign (visualization of the falciform ligament as a linear and thin density in the right upper quadrant), the right upper quadrant gas sign (visualization of localized extraluminal gas collections at this level)¹¹.

The signs most common found on the CT examination of a pneumoperitoneum are the ligamentum teres sign (free gas outlining the intrahepatic fissure and the ligamentum teres, commonly after a perforation of the stomach or duodenum), the periportal free gas sign (found in upper gastrointestinal tract perforations) and the falciform ligament sign (free gas crossing the mid-line and accentuating the falciform ligament)¹². The CT scan is considered standard criterion for the diagnosis of the pneumoperitoneum and is more sensitive than plain abdominal radiography, but is not absolutely required when we have a suspicion of pneumoperitoneum because of its cost and radiation burden and the erect chest x-ray is very sensitive on detecting the free air into the abdomen¹³.

The ultrasound is commonly used as an initial evaluation of the patients with acute abdominal pain to identify the cause as fast as possible. If the source of the pain is a perforation of a hollow abdominal viscus, it becomes essential and critical to establish an accurate diagnosis. A gas collection appears on a sonography as a result of a total sound reflection at the interface between the soft tissue and air and it is accompanied by reverberation of sound

¹⁰ "Pneumoperitoneum Imaging." Overview, Radiography, Computed Tomography. December 06, 2017. <https://emedicine.medscape.com/article/372053-overview>; Kumar A, Muir MT, Cohn SM, Salhanick MA, Lankford DB, Katabathina VS (2012) The etiology of pneumoperitoneum in the 21st century. J TraumaAcute Care Surg 73:542–548

¹¹ Levine MS, Scheiner JD, Rubesin SE, Laufer I, Herlinger H (1991) Diagnosis of pneumoperitoneum on supine abdominal radiographs. Am J Roentgenol156:340–345

¹² Coppolino F, Gatta G, Di Grezia G, Reginelli A, Iacobellis F, ValloneG, Giganti M, Genovese E (2013) Gastrointestinal perforation: ultrasonographic diagnosis. Crit Ultrasound J 5(Suppl 1):S4. doi:10.1186/2036-7902-5-S1-S4

¹³ "Pneumoperitoneum Imaging." Overview, Radiography, Computed Tomography. December 06, 2017. <https://emedicine.medscape.com/article/372053-overview>

between the gas and the transducer. As a result, the typical image of a pneumoperitoneum is formed by high amplitude linear echoes with distal artifactual reverberation echoes¹⁴.

As we published before, we obtained good result in using chest ultrasound for detection and follow-up of pneumotorax¹⁵.

METHODS

In the period between 1996 and 2007 the literature published on PubMed and MEDLINE was searched for studies on the ultrasonographic diagnosis of the pneumoperitoneum. The search was performed by two investigators (A.C. and B.S.) who have found four relevant studies.

RESULTS

In 2002 a prospective clinical study of the accuracy of ultrasound in the detection of the pneumoperitoneum was published in which a population of 132 patients from March 1996 to March 1999 with suspected hollow organ perforation was examined⁷. The suspected hollow organ perforation was defined as peptic ulcer perforation and appeared at patients presenting with sudden onset of a severe abdominal pain.

The results of this study showed that the abdominal sonography is superior to the right chest radiography and left lateral decubitus abdominal radiography. The ultrasound examination had a sensitivity of 93% while the radiography had 79%, the specificity was the same for both (64%), positive predictive value 97% for the sonography and 96% for radiography and the negative predictive value 44% in the case of sonography and 21% for chest radiography.

The conclusion of the study was that ultrasonography is superior to plain radiography in the case of diagnosis of the pneumoperitoneum. The ultrasound can diagnose it when the radiography failed to reveal pneumoperitoneum in patients with hollow organ perforation suspicion¹⁶.

Also in 2002 was performed a study comparing ultrasonography with plain abdominal radiography on a population of 188 patients with suspected hollow organ perforation. As a result, the sonography had better sensitivity (92% while the radiography had 78%), negative predictive value (39% versus 20%) and accuracy (88% for ultrasound and 76% for radiography) and the same specificity (53%) and positive predictive value (95% ultrasound and 94% the radiography). Their conclusion was that the ultrasound is more sensitive than the plain abdominal radiography in the diagnosis of the pneumoperitoneum¹⁷.

A prospective study was performed in 2004 on seventy-two patients with suspected gastrointestinal tract perforation, who were examined radiographic and ultrasonographic. A new ultrasonographic technique was tested (the scissors maneuver) consisting in applying and then releasing slight pressure onto the abdominal wall with the caudal part of a parasagittally oriented linear array probe.

¹⁴ Pattison P, Jeffrey RB Jr, Mindelzun RE, Sommer FG (1997) Sonography of intraabdominal gas collections. *Am J Roentgenol* 169:1559–1564

¹⁵ Constantin V, Carap AC, Zaharia L, Bobic S, Ciudin A, Brătilă E, Vlădăreanu V, Socea B. High correlation of lung ultrasound and chest X-ray after tube drainage in patients with primary spontaneous pneumothorax: can we omit X-rays for tube management? *Eur Surg* 2015, 47(4):175-180. DOI 10.1007/s10353-015-0333-9

¹⁶ Chen SC, Wang HP, Chen WJ, Lin FY, Hsu CY, Chang KJ, Chen WJ (2002) Selective use of ultrasonography for the detection of pneumoperitoneum. *AcadEmerg Med* 9:643–645

¹⁷ Chen SC, Yen ZS, Wang HP, Lin FY, Hsu CY, Chen WJ (2002) Ultrasonography is superior to plain radiography in the diagnosis of pneumoperitoneum. *Br J Surg* 89:351–354

The specificity and sensitivity of the radiography and sonography were the same, sensitivity 94% and specificity 100% and the scissors maneuver was positive in all patients with pneumoperitoneum detected ultrasonographically. The conclusion of the authors was that the maneuver is useful to improve the pneumoperitoneum sonographic diagnosis¹⁸.

Another prospective study was published in 2007, which had the purpose to validate the Enhanced Peritoneal Stripe Sign in the diagnosis of the pneumoperitoneum in patients with acute abdomen signs. The population studied was admitted in a period of 3 months in the emergency department and their work up included abdominal sonography, plain radiographs and/or abdominal computed tomography.

The Enhanced Peritoneal Stripe Sign was positive in all 21 patients with pneumoperitoneum and other three were found to have false positive results, but there were none false negatives. The Enhanced Peritoneal Stripe Sign has a sensitivity of 100%, specificity of 99%, positive predictive value of 87.5% and negative predictive value of 100%. Therefore, the Enhanced Peritoneal Stripe Sign is an accurate sonographic sign and it can be reliable for the diagnosis of the pneumoperitoneum¹⁹.

CONCLUSIONS

The abdominal sonography is essential in a rapid diagnosis of the pneumoperitoneum because it can be performed quickly at the bedside of the patient.

The search of the sonographic signs of pneumoperitoneum should be included in emergency protocols such as FAST and RUSH.

Most of the studies found by the investigators have a low statistic value because they were not randomized controlled trials.

In the near future we suggest initiating a randomized control trial to see the accuracy of the sonography compared with computed tomography and plain radiography in the diagnosis of the pneumoperitoneum.

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¹⁸ Karahan OI, Kurt A, Yikilmaz A, Kahrman G (2004) New method for the detection of intraperitoneal free air by sonography: scissors maneuver. *J Clin Ultrasound* 32:381–385

¹⁹ Asrani A (2007) Sonographic diagnosis of pneumoperitoneum using the ‘enhancement of the peritoneal stripe sign’. A prospective study. *Emerg Radiol* 14:29–39

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