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Mini Review

Pneumoperitoneum – Can It Be Diagnosed by Ultrasound?

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Abstract

Hollow organ perforation is a life-threatening condition and early diagnosis of perforation is important in improving the prognosis of these patients. The physical phenomenon that then occurs in the abdominopelvic cavum is the presence of extraluminal gas. The basic methods of detecting free gas in the peritoneal cavity are radiological: plain abdominal radiography, ultrasound and computed tomography. In the radiological literature, there is still no clear consensus which technique is optimal for the detection of pneumoperitoneum – plain abdominal radiography, ultrasound or computed tomography. CT is the gold standard for diagnosis but is often preceded by long wait times and unnecessary radiation exposure. Abdominal ultrasound can also be used as an adjunct in decision-making for justifying the risks of transporting a critically ill patient for further imaging. Based on the data presented, it can be assumed that ultrasonography should be treated as the basic method in diagnosing pneumoperitoneum. CT is the gold standard for the diagnosis of pneumoperitoneum, which can also help detect the cause of pneumoperitoneum.

Introduction

Hollow organ perforation is a life-threatening condition and early diagnosis of perforation is important in improving the prognosis of these patients. The physical phenomenon that then occurs in the abdominopelvic cavum is the presence of extraluminal gas. The basic methods of detecting free gas in the peritoneal cavity are radiological: plain abdominal radiography, ultrasound and computed tomography. Plain abdominal radiography is the first radiological method in case of suspected pneumoperitoneum. It is most often performed in a standing position when the detection of free subdiaphragmatic gas is easiest. Although erect abdominal plain radiograph is regarded as the standard method for diagnosing of pneumoperitoneum. It is reported that 20%–62% of hollow viscus perforation might be missed by abdominal plain film [1,2]. Very often, patients with hollow organ perforation are in poor general condition and they are unable to stand during imaging. In those cases, radiography is performed in the lying position or in left lateral decubital position when the detection of free gas under right diaphragm is expected, which is significantly less sensitive. In such a case, if the amount of gas is not sufficient for the detection of pneumoperitoneum or the imaging technique does not allow it, ultrasound is the next radiological method of detecting pneumoperitoneum. In case of clinical suspicion of pneumoperitoneum, ultrasound should be used before computed tomography.

Computed Tomography (CT) is considered the "gold standard" for the recognition of free intraperitoneal air; however, is not a cost-effective option as a screening test for patients with acute abdominal pain, exposes to significant radiations, is not always available in every centers and requires patients to be transferred for examination [3,4]. Ultrasound is a fast, accessible, non-invasive diagnostic examination method that does not involve ionizing radiation and can be repeated. It is vital in detecting free fluid in the abdominal cavity, acute pathological conditions of parenchymal and hollow organs, and assessing volemic status [5]. The utility of ultrasound could potentially be useful as an adjunct to the diagnosis of pneumoperitoneum. This is partly due to the reliability of the initial user-operator diagnosis, as well as the difficulty in recognizing typical ultrasound features such as the peritoneal stripe sign, patient factors, and differentiating artefacts caused by underlying organs and structures [6].

Technique

In order to optimally detect pneumoperitoneum during the ultrasound examination, the patient should lie on his back. Either a convex or linear transducer can be used, but the high-frequency (4–8 MHz) linear transducer is preferred. It is best to examine the upper right quadrant of the abdomen because acoustic window of the liver will enable the detection of pneumoperitoneum by ultrasound.

Pneumoperitoneum can be seen on ultrasound by two clear signs:

1. The air within the peritoneal space rises and causes an Enhanced Peritoneal Stripe Sign (EPSS) – (Figure 1)

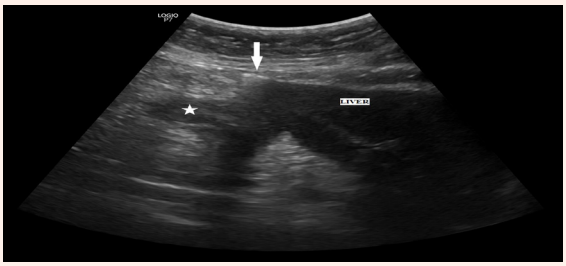

Figure 1: Abdominal ultrasound – coronal plane: the air within the peritoneal space (arrow) caused by duodenal ulcer perforation (star).

2. In the setting of large amounts of free air, the ultrasound operator can visualize reverberation artifact deep to the peritoneal stripe, similar to A-lines seen in normal lung tissue ("A-lines in the abdomen") [7].

Due to the nature of the anatomical relationships in the abdomen, there is a large number of contacts between the gas in the intestinal lumen and the surrounding tissue (most often the peritoneum or its duplicates). For this reason, it is sometimes difficult to distinguish gas in the intestinal lumen from extraintestinal gas representing pneumoperitoneum. For this reason, several indirect ultrasound signs have been described to help distinguish intraintestinal from extraintestinal gas. Intraperitoneal free air is generally located under the abdominal fascia and does not show respiratory mobility [8]. Other ultrasound signs of perforation are perivisceral fat hyperechoic reaction, presence of extraluminal fluid with septations, thickening of the bowel wall and a focal defect in the bowel wall.

Discussion

In the radiological literature, there is still no clear consensus which technique is optimal for the detection of pneumoperitoneum – plain abdominal radiography, ultrasound or computed tomography. CT is the gold standard for diagnosis but is often preceded by long wait times and unnecessary radiation exposure. Abdominal ultrasound can also be used as an adjunct in decision-making for justifying the risks of transporting a critically ill patient for further imaging. A recent study designed to identify the most effective diagnostic strategy for patients with acute abdominal pain demonstrated that the highest sensitivity for detecting urgent diagnoses is achieved when ultrasonography is performed in all patients and CT only in the event of inconclusive or negative ultrasonography (conditional CT strategy). When this strategy is used, CT is only needed in 49% of patients [9]. Nonetheless, CT remains the gold standard for diagnosing a perforated viscus [10]. This strategy has significantly increased the importance of ultrasound in the diagnosis of pneumoperitoneum, but it has several lacks: ultrasound is operator dependent technique but also machine dependent, it is still unclear what amount of free gas is necessary for ultrasound to detect, ultrasound cannot detect other causes of pneumoperitoneum (peritoneal dialysis, intraabdominal infection, intrathoracic or gynecological causes) and ultrasonographic doctors are not always 24 h available in all centers. Ultrasound can also help in the detection of traumatic pneumoperitoneum in the FAST protocol (Focused Assessment with Sonography for the Trauma), which can speed up the protocol of diagnosis and treatment of traumatized patients [11]. In those cases, the ultrasound should be focused on the region that is most susceptible to trauma - in the case of deceleration force, attention should definitely be paid to the places where the mesenterim is fixed to the posterior abdominal wall - these are the duodenojejunal flexure and the terminal ileum. In the case of penetrating trauma, a more detailed examination will certainly be done in the region of the stab wound, especially if it is close to the fixed segments of the colon (ascending and descending part) and duodenum (descending part).

Conclusion

Pneumoperitoneum is a clinical condition that requires quick and accurate diagnosis and urgent treatment. Based on the data presented, it can be assumed that ultrasonography should be treated as the basic method in diagnosing pneumoperitoneum. In the absence of direct ultrasound signs of pneumoperitoneum, an urgent CT examination should be performed which can successfully detect, except pneumoperitoneum, its causes and therefore precipitate treatment.

Conflicts of interest: None

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References

1. Shaffer HA Jr (1992) Perforation and obstruction of the gastrointestinal tract. Assessment by conventional radiology. Radiol Clin North Am 30(2): 405-426.
2. Woodring JH, Heiser MJ (1995) Detection of pneumoperitoneum on chest radiographs: comparison of upright lateral and posteroanterior projections. Am J Roentgenol 165(1): 45-47.
3. Hainaux B, Agneessens E, Bertinotti R, De Maertelaer V, Rubesova E, et al. (2006) Accuracy of MDCT in predicting site of gastrointestinal tract perforation. Am J Roentgenol 187(5): 1179-1183.
4. Bulas DI, Taylor GA, Eichelberger MR (1989) The value of CT in detecting bowel perforation in children after blunt abdominal trauma. Am J Roentgenol 153(3): 561-564.
5. Vasin D, Pavlovic A, Stojadinovic M, Mijovic K, Maricic B, et al. (2021) Urgent ultrasonographic diagnostics in acute nontraumatic abdominal conditions. SJAIT (7-8): 155-165.
6. Khor M, Cutten J, Lim J, Weerakkody Y (2017) Sonographic detection of pneumoperitoneum. BJR Case Rep. 3(4): 20160146.
7. Indiran V, Kumar RV, Jefferson B (2018) Enhanced peritoneal stripe sign. Abdominal Radiology. 43: 3518-3519.
8. Abu-Zidan FM, Cevik AA (2018) Diagnostic point-of-care ultrasound (POCUS) for gastrointestinal pathology: state of the art from basics to advanced. World J Emerg Surg 13: 47.
9. Lameris W, Van Randen A, Van Es HW, Van Heesewijk JPM, van Ramshorst B, et al. (2009) Imaging strategies for detection of urgent conditions in patients with acute abdominal pain: diagnostic accuracy study. Br Med J 338: b2431.
10. Stapakis JC, Thickman D (1992) Diagnosis of pneumoperitoneum: abdominal CT vs upright chest film. J Comput Assist Tomogr 16(5): 713-716.
11. Vasin D, Pavlovic A, Stojadinović M, Tomic T, Vukmirovic J, et al. (2021) Urgent ultrasonographic diagnostic in acute traumatic abdominal conditions. SJAIT 43: 81-90.