Ultrasound diagnosis of pneumoperitoneum: a case report

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Abstract

Pneumoperitoneum, or free air in the abdominal cavity, has traditionally been a diagnosis made with conventional radiographs in the acute abdomen series. Computed tomography (CT) is a sensitive diagnostic tool in detecting free air, but remains an expensive examination rendering it unfavourable. Since the early 1980s it has emerged that ultrasound can be diagnostic in cases of pneumoperitoneum. This however is by and large a little known fact and rarely trusted explicitly. This is a single case report in which ultrasound proved to be useful in the detection of intra-abdominal air.

Key words: *abdomen, free air, perforation*

Case report

A 51 year-old man undergoing chemotherapy for lymphoma presented to the radiology department from the oncology ward. The request form read: abdominal ultrasound for query diverticulitis. The patient appeared pale, was febrile and complaining of severe left iliac fossa pain. Although he was able to stand he was stooping in pain.

The upper abdomen was initially surveyed with a 3.5 Megahertz (MHz) curved transducer and standard protocol adhered to for the solid abdominal viscera. The pelvis was also interrogated using the 3.5 MHz probe and revealed a moderate amount of free fluid in the pelvic cavity, an unusual finding in a male patient.

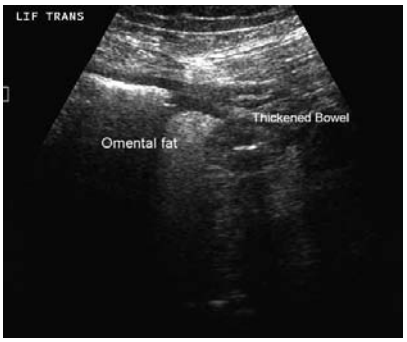

Figure 1: Left Iliac fossa demonstrating inflamed omental fat and thickened bowel wall

The iliac fossa being the area of maximal tenderness was then scanned with a 7.5 MHz linear transducer and a sector field of view. In this region the omental fat appeared echogenic, indicative of inflammatory changes; the bowel wall was thickened (Figure 1). Although the typical landmark signs of diverticulitis were not seen this pathology could not be ruled out. While scanning this region a thin layer of air was noted just posterior to the anterior abdominal wall (Figure 2).

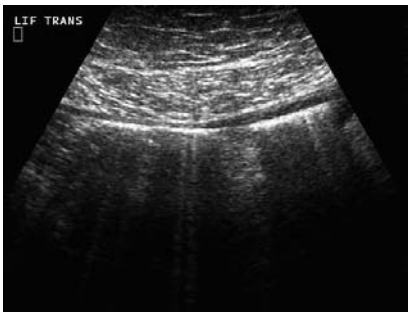

Figure 2: Free air seen posterior to the anterior abdominal wall

This air was seen to be moving independently to the peristalsis of the underlying colon. It should be noted that similar air interfaces seen in the normal abdomen represents air in the colon and can be confirmed by observing the peristaltic movement of the structure in which it lies.

The patient was then turned onto his left side into the lateral decubitus position. He was then scanned intercostally using the 7.5MHz linear probe. In this position the free air was seen as an echogenic line on the surface of the liver with

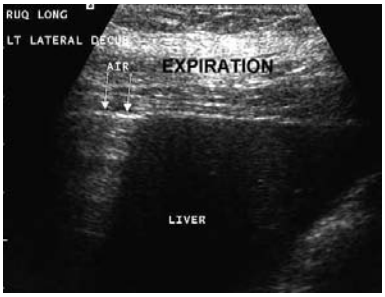

Figure 3: Reverberation from free air anterior to the liver the 'interface echopattern'

reverberation artefact behind it (Figure 3). This has been described as the 'interference echo-pattern' [1]. To confirm the air was intra-abdominal and not in overlying air-filled lung, views in expiration and inspiration were obtained as a study by Lee *et al* [2] describes this technique, which aids one to differentiate free gas

Figure 4: Air in lung

within the peritoneal cavity and air in the lung. Air in the lung also displays the same characteristics as the interference echo-pattern and may be confused with free air in the abdomen (Figure 4). In expiration the free air is seen superficial to the liver (as seen in Figure 3), however, this is not proven to be within the abdominal cavity. On inspiration the inflated lung is seen traversing down in front of the gas collection, thus proving its

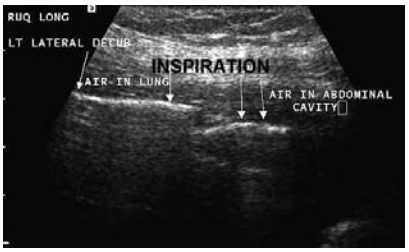

Figure 5: Air in the lung is seen as separate from the intra-abdominal air

intra-abdominal location (Figure 5). This is described as the 'interface echopattern and shifting phenomenon'. [3] This technique involves the detection of the interface echopattern and observing its movement or 'shift' in differing positions, from for example, supine to decubitus. Detection of a shift is indicative of free intra-abdominal air and distinguishes it from air-filled lung and intraluminal air in the bowel, which both display the interference echopattern, but will not produce the shifting phenomenon [3].

To confirm the presence of a pneumoperitoneum the protocol for acute abdomen radiographs was performed. Free air was noted under the diaphragm on the erect postero-anterior chest radiograph (Figure 6). Based on these findings a perforation was highly suspected, although the source could not be determined. A perforated diverticulum was suggested to be the most likely cause. The patient underwent exploratory surgery, which revealed multiple small perforations of the small intestine in the region of the left iliac fossa. Most of the perforations had been self-limiting and were sealed off, however the largest was open and was no doubt causing the free air in the abdominal cavity and localised peritonitis. A length of the small intestine was removed during the operation. After a short period in the intensive care unit the patient fully recovered. It was postulated the patient's ongoing chemotherapy was the causal agent because chemotherapy affects the ability of normal cells to undergo their mitotic cycle [4]. It was thought that the treatment had affected the process of regeneration of the intestinal lining causing thinning of the bowel wall and eventual perforation.

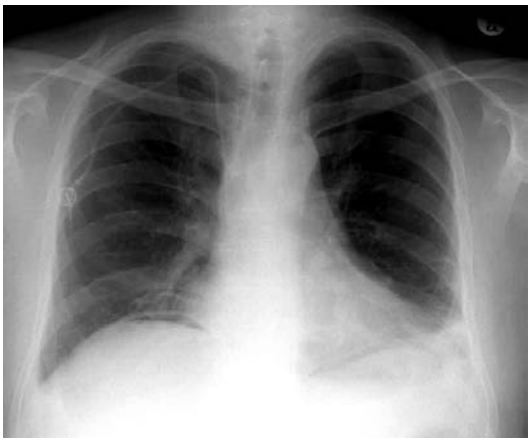

Figure 6: Free air under the diaphragm on the PA erect chest radiograph

Discussion

Ideally for the acute abdominal series with conventional x-rays the patient should be erect for five to ten minutes preceding the exposure, to ensure the free air has had time to rise to its highest position [5]. In reality, this is sometimes unreasonable and unattainable, given the severe pain these patients are often in. Left lateral decubitus radiographs with a horizontal beam technique can also be used but are sometimes inadequate due to technical factors. CT is useful, but is expensive and does not allow for mobile examinations. Ultrasound carries a number of advantages, especially in the case of patients who are in severe pain or are immobile. The patient can be scanned in a combination of the supine and decubitus positions, eliminating the need to stand erect for any amount of time. The ultrasound machine is also portable, making it easily accessible to ward and intensive care patients. Ultrasound has the added advantage of allowing the sonographer/operator:

- to identify the source of perforation,
- to note and comment on concurrent pathology ,and
- in some cases offer alternative solutions to the suggested differentials.

The pitfalls of ultrasound include:

- operator dependence, which can impact on pattern recognition and could have detrimental results for the patient,
- confusion between true intra-abdominal free air and air filled lung or intra-colonic gas interposed anterior to the liver [6].

In some extreme cases it may be impossible for the patient to lie in the left lateral decubitus position making confirmation of intra-abdominal air difficult.

On plain-film examination as little as 1ml of free air may be seen [7]. The minimum amount seen on ultrasound has not been quantified in the literature, but it has been suggested that it is more sensitive in detecting pneumoperitoneum [8,9]. It is also difficult to utilise the ultrasound method for serial examination in post-laparoscopy patients where the quantity of free air is important to determine increasing amounts of free air in the case of perforation, compared with stable or decreasing amounts in the normal post-operative patient. One of the major disadvantages of ultrasound is purely lack of confidence, but this should improve with experience.

Concluding remarks

Conventional radiographs of the abdomen have long been the preferred examination for the diagnosis of pneumoperitoneum. In this case discussed ultrasound proved to be useful in the detection of free intra-abdominal air. However due to lack of confidence in this imaging modality the patient underwent a correlative acute abdomen series anyway. Perhaps with further experience and increased confidence in ultrasound findings it could be used as the initial examination of choice in cases of suspected perforation.

References

1. Chang-Chien C, Lin H, Yen C, Lee C & Lin S. 1989. Sonographic Demonstration of Free Air in Perforated Peptic Ulcers: Comparison of Sonography with Radiography. *J Clin Ultrasound*. **17 (2)**: 95-100
2. Lee DH, Lim JH, Ko YT & Yoon Y. 1989. Sonographic Detection of Pneumoperitoneum in Patients with Acute Abdomen. *AJR*. **154 (1)**: 107-109
3. Chang-Chien C, Lin H, Yen C, Lee C & Lin S. 1989. Sonographic Demonstration of Free Air in Perforated Peptic Ulcers: Comparison of Sonography with Radiography. *J Clin Ultrasound*. **17 (2)**: 95-100
4. *Introduction to Chemotherapy* http://training.seer.cancer.gov/module_cancer_treatment/unit3_chemol_intro.html (Accessed: August 2003)
5. Grainger RG & Allison DJ. 1992 *Diagnostic Radiology an Anglo-American textbook of imaging Volume 2* 2nd Edition. Edinburgh: Churchill Livingstone
6. Chen SC, Yen ZS, Wang HP, Lin FY, Hsu CY & Chen WJ. 2002. Ultrasonography is superior to plain radiography in the diagnosis of pneumoperitoneum. *British Journal of Surgery*. **89**: 351-354
7. Grainger RG & Allison DJ. 1992 *Diagnostic Radiology an Anglo-American textbook of imaging Volume 2* 2nd Edition. Edinburgh: Churchill Livingstone
8. Chang-Chien C, Lin H, Yen C, Lee C & Lin S. 1989. Sonographic Demonstration of Free Air in Perforated Peptic Ulcers: Comparison of Sonography with Radiography. *J Clin Ultrasound*. **17 (2)**: 95-100
9. Chen SC, Yen ZS, Wang HP, Lin FY, Hsu CY & Chen WJ. 2002. Ultrasonography is superior to plain radiography in the diagnosis of pneumoperitoneum. *British Journal of Surgery*. **89**: 351-354