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EDITORIAL

Pneumoperitoneum—the radiographic and clinical virtues of the supine abdominal film

Stephen R. Baker

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The recognition of pneumoperitoneum remains a quintessential challenge for diagnostic radiologists in both affluent and developing countries, although one of the major causes of spontaneously generated free air– perforated gastric and duodenal ulcer– has decreased in incidence. Nevertheless, the condition is, by no means, rare. It is up to the radiologist to observe and report it especially when the amount of liberated air is small and its roentgenographic appearances are subtle, because then only he or she is trained to see it. A prompt diagnosis can be crucial in any event because it may be the difference between recovery and survival on one hand and death on the other.

Despite the widespread deployment of CT, which is nearly universal in acute care hospitals in industrialized nations and increasingly prevalent in imaging facilities in emerging countries, pneumoperitoneum often is diagnosable on conventional radiography. A plain film study is readily available in places where CT is not. It is comparatively inexpensive and can be performed portably.

Therefore, a comprehensive knowledge of the subtleties of plain x-ray interpretation is still a measure of competence of any fully qualified radiologist. Surprisingly, perhaps, unlike many other diagnoses that lend themselves to definitive recognition without the benefit of cross-sectional imaging techniques, new insights are still being gleaned with respect to the incisiveness of plain films for free air detection even now. It is not just part of an unchanging canon but one that still accommodates novel signs. In a recent article in this journal by Bansal et. al. "Effectiveness of plain radiography in diagnosing hollow viscera perforation: study of 1,723 patients with perforation peritonitis" [1], the evaluation of the abdomen by x-ray is based on notions which were well established by 1995. And to some extent, it is neglectful of recent discoveries and practices based on those discoveries [2].

The traditional means of plain film assessment of free air is to observe its presence as revealed on upright or left lateral decubitus images. Although there are a wide range of patterns depicting the accumulation of intraperitoneal gas when the amount liberated from the tubular GI tract is abundant, the value of the upright and side-lying recumbent views is that it can detect small volumes when the freed gas (or air) is situated over the homogeneous shadow of the liver.

The sensitivity of these plain radiography views was established by a landmark article by Miller and Nelson in 1971 [3]. Based upon the recognition of varying aliquots of air injected into Miller's peritoneal cavity, as little as 1 cm^3 could be observed on horizontal beam views. And this tiny amount has been generally recognized as the limit of conventional imaging. By the way, Miller and Nelson's accompanying supine view was a KUB which had its upper margin situated just above the right kidney. Hence, it did not reach the apex of the right hemidiaphragm, which is important to note because air is apt to reside over the uppermost liver even when the patient is lying down and face up.

However, the advent of CT has questioned Miller's conclusion. First, CT can certainly recognize even smaller amounts of intraperitoneal air or gas. Other methods including sonography have been touted for their efficacy in this regard [4–7]. But in order to compare each of them with the gold standard of CT, they must be shown to be equally effective in clinical situations at nearly the same time, without a change in position of the patient during the interval between the candidate imaging test and the computed

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S. R. Baker (✉)
Department of Radiology, New Jersey Medical School, UMDNJ,
150 Bergen St. UH C318,
Newark, NJ 07103, USA
e-mail: bakersr@umdnj.edu

tomography scan. The only non-CT conventional image that could be compared without changing patient position or allowing a measure of time between it and the advent of the CT study is a supine film obtained as the digital scout view as part of the immediately performed full CT scan. In this context, we have observed that both CT scans and supine views can demonstrate gas collections much smaller than 1 cm^3 [8–19]. In fact, we have noted free air deposits occupying only 0.004 cm^3 which is the volume of a sphere of air or gas approximately two mm in diameter. Moreover, we have confirmed that the equal sensitivities of tiny collections of this size on CT and supine films that overlay the liver by simulating it with phantom studies using a water bath and graduated plastic diameters mimicking bubbles in size and configuration [2].

Actually, this result should not be startling, because small bubbles are observable on nearly every supine abdominal film since they are routinely present in fecal deposits in the colon. The reason they have not been widely accepted as a plain film finding is because the typical supine image of the abdomen is obtained as a KUB for which, as a matter of course, the upper margin of the kidney is designated the rostral border of the image. But the peritoneal cavity extends from the obturator foramen inferiorly to the apex of the higher hemidiaphragm superiorly. Hence, in most KUBs of averaged-sized adults, the superior half of the hepatic shadow is not included on the film and, therefore, small collections of intraperitoneal air are not seen either. Therefore, the proper radiologic evaluations of the abdomen of a supine patient must include at least two views to encompass the full cranio–caudal extent of the peritoneal cavity.

Why is this point important and not merely nitpicking? Reliance on the upright abdomen view or the upright chest view requires an erect patient. Yet such individuals are often in pain or otherwise acutely sick and standing up unaided puts them at risk if indeed they can cooperate. If the patients are weakened or hypotensive, that is a challenge they should not be made to endure even for a few minutes. Moreover, pneumoperitoneum can occur silently with profound consequences in obtunded, unconscious, and demented individuals who cannot assume a standing or sitting up position even if they wished to. Furthermore, it can be symptom-free initially in patients receiving steroid or pain medication.

Therefore, it should be assessed with the patient recumbent and facing up. Any investigation that ignores or minimizes the supine view, or is heedless of its capabilities when properly performed, will miss instances of free air in some patients and subject others to the risks of assessing the erect position even though they may be enfeebled. Consequently, Bansal et al. in their paper are right to emphasize the enduring value of plain film for free air but they also mislead by ignoring the value of the readily available, patient friendly, supine image. The mandatory erect film should be "retired" and a full evaluation of the entirety of supine abdomen should replace it as a matter of course.

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