Problems Imaging the Morbidly Obese Patient

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The adverse health effects of the obesity epidemic have been well chronicled in this issue of JLGH and throughout the literature. Less discussed is what happens to the obese patient once they become ill. What effect does body habitus have on our ability to diagnose and treat the patient? In 21st century medicine, the nexus of diagnosis is imaging, and the negative impact of morbid obesity in diagnostic imaging is profound, if seldom mentioned. If anyone should doubt the severity of the problem, this author read fewer than 30 examinations to identify 6 patients' images to illustrate this article.

It is important to recognize that we are referring to the truly obese in this discussion, not the mildly overweight individual. While increased body fat can limit some modalities, like ultrasound, a few extra pounds of fat can actually help to evaluate the patient when using computed tomography (CT). It is much easier to diagnose appendicitis by CT in an overweight 50 year old than in a skinny 9 year old. Intraperitoneal fat surrounds the bowel and internal organs, provides a natural contrast agent, and makes the appendix easy to find. When the appendix is surrounded by

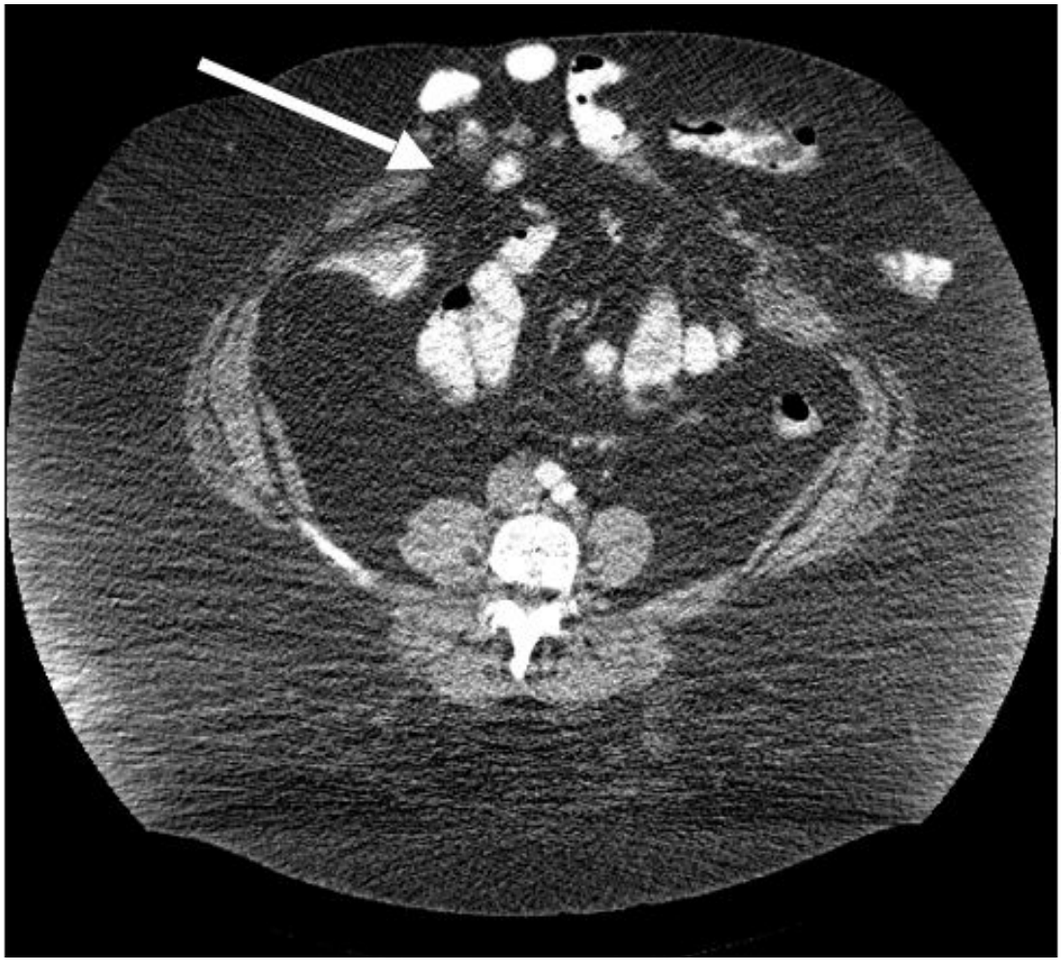

Fig 1. CT of the abdomen shows marked loss of detail, especially around the edges of the image where the patient's body is in contact with the scanner. The patient also has a large ventral hernia (arrow), common in the morbidly obese.

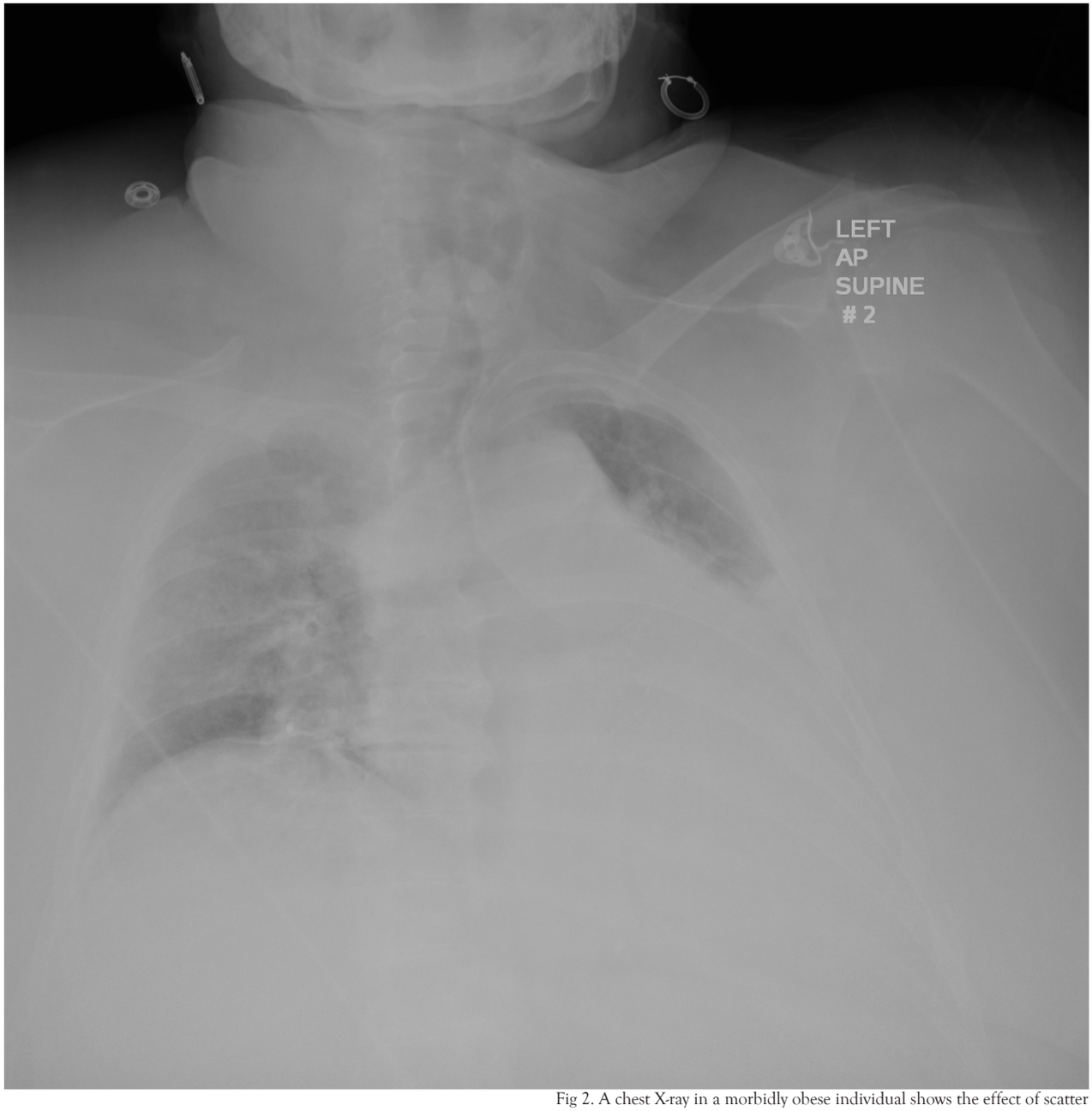

Fig 2. A chest X-ray in a morbidly obese individual shows the effect of scatter radiation. The image is grey and indistinct. Very little detail can be seen in the lungs.

nothing but other loops of bowel, as it is in most children, it can be difficult or impossible to find, especially without contrast material in both the bowel and vasculature.

The problems of imaging the morbidly obese can be divided into two broad categories. The first are physical limitations of the imaging equipment and supplies, and the second relate to the imaging medium itself, whether X-rays, sound waves, or excited protons, as in MRI.

To be studied with modern imaging equipment the patient must usually be lying on a mobile surface, in order to move the appropriate part of the body into the x-ray beam. Particularly with CT, accurate imaging requires this motion to be very precisely calibrated both in location and speed. Heavy patients severely tax or can even break the mechanism on which the patient is lying. All X-ray equipment vendors specify weight limits for their equipment, typically in the high 300 to low 400-pound range. Placing patients larger than this on the table risks injury to the patient and damage to the equipment, and it specifically voids any warranty provided by the manufacturer.

Equipment that encircles the patient, like CT and MRI, must have a bore large enough to accommodate obese patients without allowing them to touch the sides of the device, which produces artifacts. (Fig 1) Making larger bores for CT and MR would seem the obvious solution, but doing so introduces compromises, as the further the sensor is from the patient, the lower the strength of the signal. This is not a linear effect but an inverse square, so putting an MRI coil twice as far from the organ of interest (e.g. 6 cm instead of 3 cm) leads to a 4-fold loss of signal. So-called open MRI's use a number of tricks to overcome this problem, but all involve some loss of information.

Interventional equipment must cantilever the patient over the x-ray tube, and the table must travel long distances to be able to cover from head to toe. Morbidly obese patients cannot be put on such devices without damaging the table. Even the needles, catheters, and wires used for interventional procedures do not usually come in sizes long enough to use in the extremely large patient. All who do these procedures have encountered patients in whom "you just can't get there from here," and the nodule or kidney stone may be beyond the reach of the available needles, even if the lesion can be seen. Also, hitting a 1 cm target that is 20 cm away is much harder than hitting the same lesion at 10 cm, as any slight error in direction is amplified as one goes deeper.

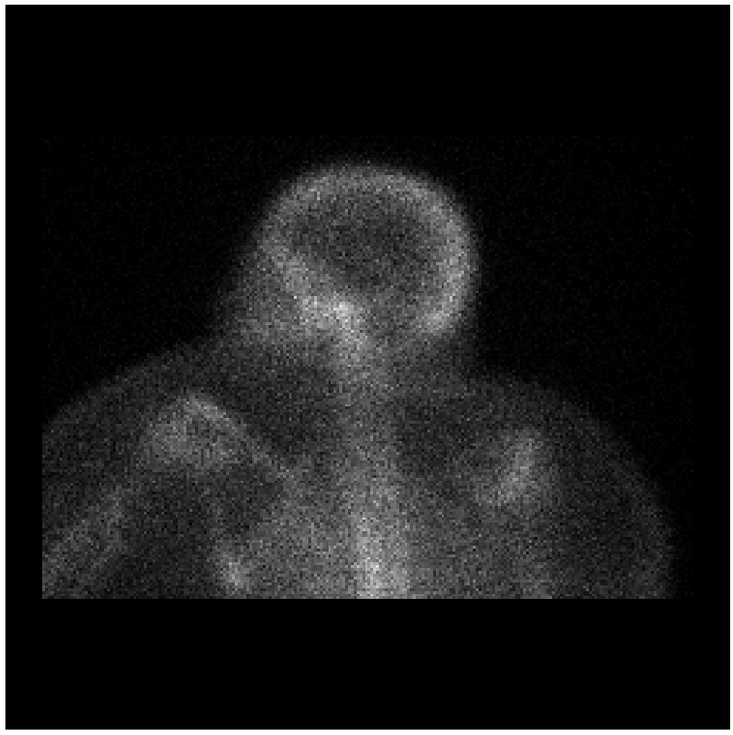

Fig 3 Nuclear medicine bone scan. The bones can barely be seen, and individual vertebrae cannot be distinguished.

As the patient gets larger, the energy used to create the image becomes less effective. In the case of sonographic images, which require sound waves, penetration falls off rapidly with increasing depth. Using lower frequency sound permits greater depth, but produces much lower resolution. When X-rays are directed at the patient, the images are formed by the contrast between X-ray photons that pass through the patient and strike the detector, and those that are blocked, leaving the detector undisturbed. However, a third phenomenon, called scatter radiation, occurs when the photons are deflected by tissue in the patient, but still reache the detector. This scatter radiation contains no useful information, as it arrives from random directions and produces a uniform grey fog on the radiograph, obscuring any detail. (Fig 2) The more obese the patient, the more scatter occurs. Getting a more powerful X-ray tube does nothing to help this phenomenon. In the case of nuclear medicine studies, the radiation is injected into the patient and is detected as it passes through the tissues and out of the body. Morbidly obese patients absorb much more of this radiation before it can escape and be detected, degrading the images. (Fig 3)

In conclusion, morbid obesity causes a number of serious health problems. Alas, once ill, these patients' problems have only just begun, as our ability to diagnose and successfully treat what ails them is always difficult, and sometimes impossible.

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