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Improvement in Visualization of Hepatic Lesions with Upright Views

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Standing scintiphoto views of the liver may provide improved visualization as compared with conventional supine liver images. This is partially due to decreased respiratory motion of the liver. The standing position is recommended if the supine liver scan appears normal in a patient suspected of metastatic disease.

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There is general agreement that under ideal conditions radiocolloid images of the liver are capable of detecting discrete masses measuring about 2–2.5 cm in diam, whereas 0.6- to 0.9-cm "cold" lesions can be detected in phantoms (*1–4*). Visualization of small hepatic lesions by scintigraphy has been compromised by such factors as motion of the liver and attenuation of the radiation by the overlying tissue of liver, muscle, and breast.

Several attempts have been made to solve the problem of motion, the major component of which is due to respiration. Hoffer (*5*) and Ellings (*6*) have suggested electronic devices to lessen the degradation of gamma-camera images compromised by motion. Electronic respiratory gating of various types (*7*), breath holding (*8*), and even placing the patients in a prone position (*9*) have been used. One of the simplest solutions is positional, merely requiring that the patient assume a standing position during the imaging phase of the study (*10*). This maneuver reduces the respiratory excursions of the liver.

The visual consequences of metastases smaller than 2 cm are not yet well defined. A recent study (*11*) indicates that multiple small hepatic metastases from carcinoma of the breast may be manifested on the liver scan as heterogeneous or irregular distributions of activity, or as hepatomegaly without significant or perceptible nonhomogeneity. Improved visualization may detect small focal defects in some of these cases. Comparison of gray-scale ultrasonography with routine radionuclide hepatic scans indicates the superiority of ultrasound (*12*). This may not be true when standing radionuclide scans are routinely performed.

This paper demonstrates the benefits of the standing view, using computer technique to analyze and display the extent of the improvement.

MATERIALS AND METHODS

All patients and normal volunteers were injected with 4 mCi of Tc-99m sulfur colloid. Imaging was done with a 140-keV parallel-hole collimator on a gamma camera. Ungated and respiration-gated 500,000-count images were obtained and computer processed.

RESULTS

Figure 1 illustrates the supine anteroposterior and standing views (A,B) of a patient with known hepatic metastases

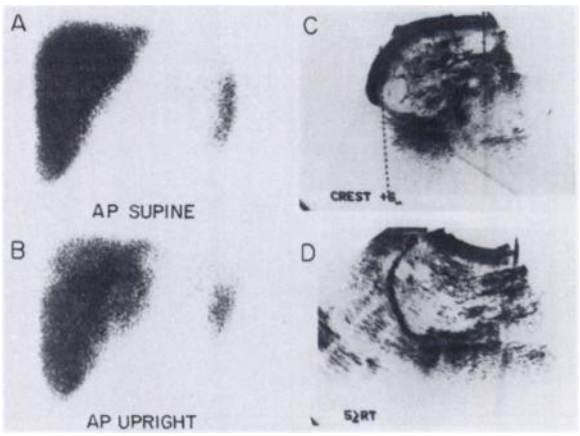

FIG. 1. Anterior hepatic scans, supine and standing, compared with longitudinal and transverse sonograms, in patient with known metastases.

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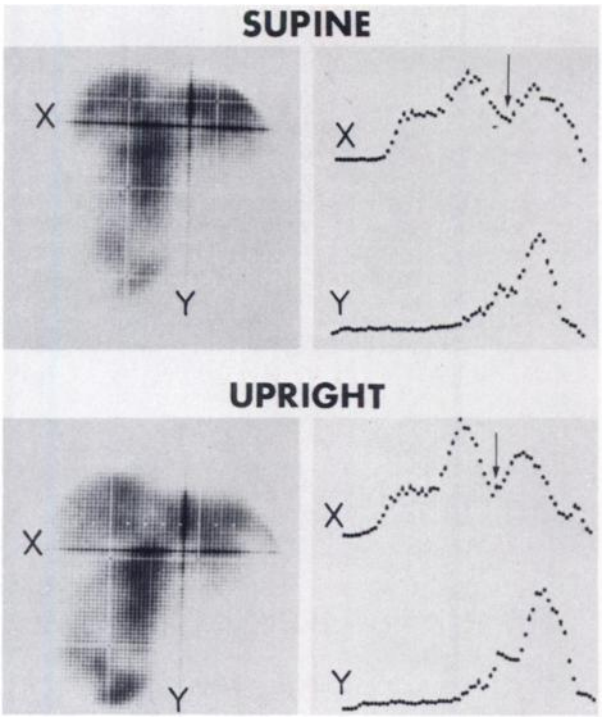

FIG. 2. Computer analysis of single defect in anterior views of patient with hepatic metastases.

from lymphoma, as well as gray-scale sonograms (C,D) performed on the same day. The standard supine views alone would have resulted in a normal interpretation of the radionuclide scan.

Figure 2 is a computer analysis of radiocolloid activity in the X- (horizontal) and Y- (vertical) axes centered on a particular defect in a patient with known hepatic metastases from carcinoma of the colon. In the resulting curves, with height proportional to activity, the standing view indicates better delineation of the lesion than does the supine.

Gated hepatic scans were performed on normal volunteers during normal resting respiration. The volunteers were unaware of the intent of the study as end-inspiration and end-expiration scans were performed. The result from a normal volunteer is shown in Fig. 3. As shown by computer analysis using an isocount line in the z- (activity) axis, respiratory motion of the liver is approximately equal (2 cm) in the supine, prone, and sitting positions, but is markedly decreased (0.5 cm) in the standing ("upright") position.

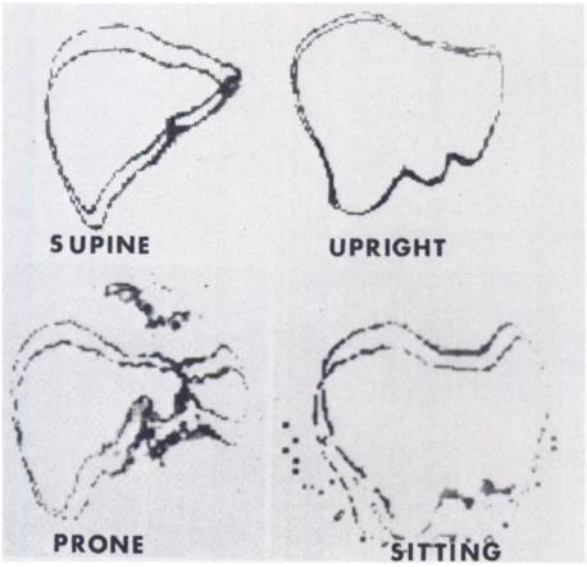

FIG. 3. Superimposed inspiration-expiration hepatic outlines from normal volunteer in supine, standing upright, prone, and sitting positions.

DISCUSSION

It is not surprising that the respiratory motion of the liver is reduced in the standing position. Agostoni and Mead (*13*) state that the "zero level"—i.e., the level at which abdominal pressure is equal to ambient pressure—is dependent upon gravitational forces and the elastic forces of the diaphragm, rib cage, abdominal wall, and lung. In the supine and prone positions, the diaphragm is stretched by the abdominal contents. The lower position of the liver in the erect position also causes the liver to change shape, as shown in Fig. 3. The liver does not appear to be closer to the gamma camera in the standing position, since in the supine position the liver is close to the anterior abdominal wall, as is demonstrated by ultrasound and body scanning.

The standing position appears to decrease respiratory motion of the liver; hence, it should be employed whenever maximal sensitivity for small focal defects is desired. An additional requirement is that the patient must be firmly held next to the camera to preclude resolution loss by patient motion. We use a Velcro strip for this purpose. Figure 3 also demonstrates that, if a patient were too sick to stand, the same effect could not be achieved in the prone or sitting positions.

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