Effect of Patient Positioning on Liver Size Estimation

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Technetium sulfur colloid imaging is widely regarded as a simple, accurate technique for the evaluation of liver size. Although numerous strategies have been proposed for standardizing measurements, none has considered the possibility of a variation depending on whether the patient is imaged erect or recumbent. We imaged several patients in both positions and observed an apparent increase in the vertical length of the liver from supine to upright. We confirmed this by demonstrating a significant increase in the vertical length of both the right and left lobes in a majority of 55 patients imaged in both positions.

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As a method of improving the sensitivity of radiocolloid scintigraphy for space-occupying disease, imaging in the upright position has been advocated since it allegedly reduces respiratory motion (*1*). The matter has been debated in the literature (*2*) and currently there is no standard practice (*3*). Standing, sitting, supine, prone, and even decubitus positions may be employed. Not only is there a laboratory-to-laboratory variation, but even within the same imaging facility, there can be no rigid protocol because of differences in patients' ability to tolerate given positions.

While a major value of radionuclide liver imaging is the determination of organ size (*4–9*), no reported method has considered a possible variation depending on whether the imaging is performed supine or erect. We evaluated an observed change in the apparent size of the liver by measuring the vertical length of the right and left lobes in the upright and supine positions in 55 cases.

MATERIALS AND METHODS

All cases were imaged ~20 min following i.v. injection of 3 mCi of technetium-99m sulfur colloid. Images in anterior, posterior, right lateral, and anterior oblique views were recorded supine, using a large field-of-view gamma camera equipped with a low-energy, all-purpose parallel hole collimator for 600,000 counts. Consecutive studies involving 36 males and 19 females were selected with the only restriction that they be able to stand for an additional anterior erect view. Images were recorded on polaroid film or transparency. The vertical dimensions of the right and left lobes were obtained using a compass and ruler graduated in millimeters. Lead markers 15 cm in length were placed at the right and left costal margins, to aid in identifying the location of the liver while providing a numerical correlation to allow quantification of absolute length.

RESULTS

Studies were divided into normal and abnormal (defects, hepatomegaly, colloid shift, or splenomegaly). Equivocal cases were regarded as abnormal. As a general guideline we regarded normal liver size as under 20 cm in vertical length at the right lateral margin (*10*), and <15 cm at the midclavicular line (*6*). Among the male patients there were 26 abnormal and ten normal studies with ten abnormal and nine normal females. In three patients the left lobe was not discretely measurable and these patients were not included in the left lobe calculations. Comparing supine with upright views, there was a 1 cm or greater increase in length in 42 of the 55 right lobes and 49 of the 52 left lobes measured. The statistical significance of the measured differences was tested by the Student's t-test for

TABLE 1
Average Increase in Measured Height with Change in Position

	Right lobe		Left lobe	
	(%)	(cm)	(%)	(cm)
Normals	6.5	1.2	27.0	2.4
Abnormals	6.7	1.4	18.1	2.0
All	6.6	1.4	21.0	2.2

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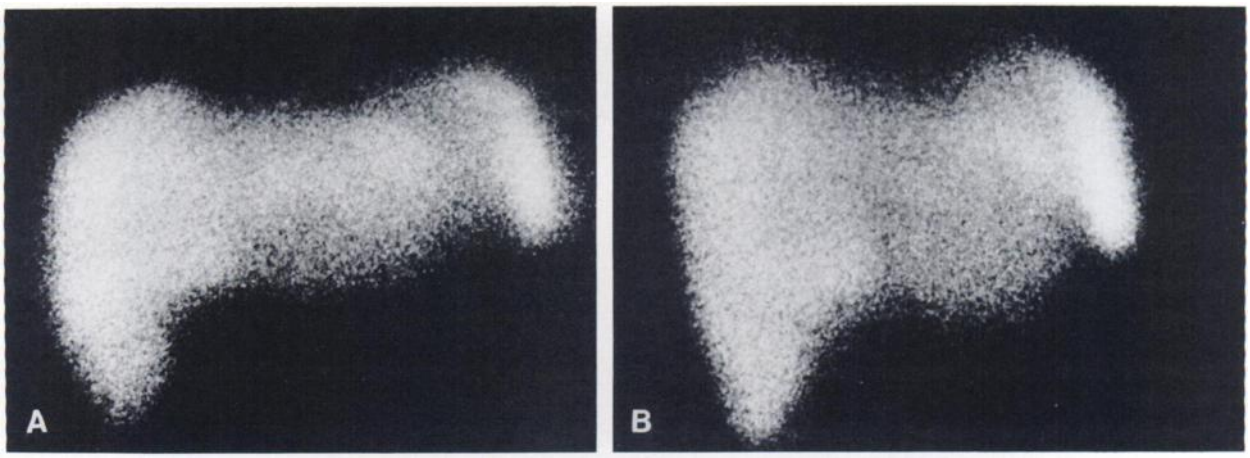

FIGURE 1
A: Supine, Left lobe is prominent in horizontal axis. B: Erect. Vertical length of both lobes is increased and interlobar fissure is now apparent as is increased splenic uptake

paired data. Both the right and left lobe differences were found highly significant at greater than the 0.001 level. The increment in left lobe size from supine to upright was greater in normal patients, with an average increase of 27.0% compared with 18.1% in the abnormal group. The right lobe change was less dramatic, 6.5% for normals and 6.7% for abnormals. Further analysis by age group (0–19, 20–39, 40–59, 60 and above) and sex revealed no remarkable variation. The results are summarized in Table 1. Representative cases are shown in Figs. 1 and 2.

DISCUSSION AND CONCLUSION

We have confirmed statistically an empirical observation that the liver appears larger on the anterior view with the patient erect when compared to a supine image. The difference is apparent in the great majority of both normal and abnormal studies, more so in the left lobe than the right, particularly in normal patients. This can be explained in view of the known pliability of the liver which is lost to varying degrees in diffuse parenchymal and space occupying disease (*1,11*). The distinction between normal and abnormal liver size is complicated by the nonuniform dimensions as well as the known variability in shape among normals. Extrinsic abnormalities such as pulmonary disease, eventration of the diaphragm or abdominal masses can distort the normal configuration of the liver. Numerous suggestions have appeared in the literature for evaluating hepatic size (*6, 7,9,12–14*), but the most widely used method is "eyeballing", i.e., a subjective impression based on one's past experience. Whichever method is chosen, including the subjective, a noticeable difference in vertical length of the liver from supine to upright is likely to lead to misinterpretation in laboratories where both upright and recumbent positions are employed. The problem is particularly significant in patients whose liver size is

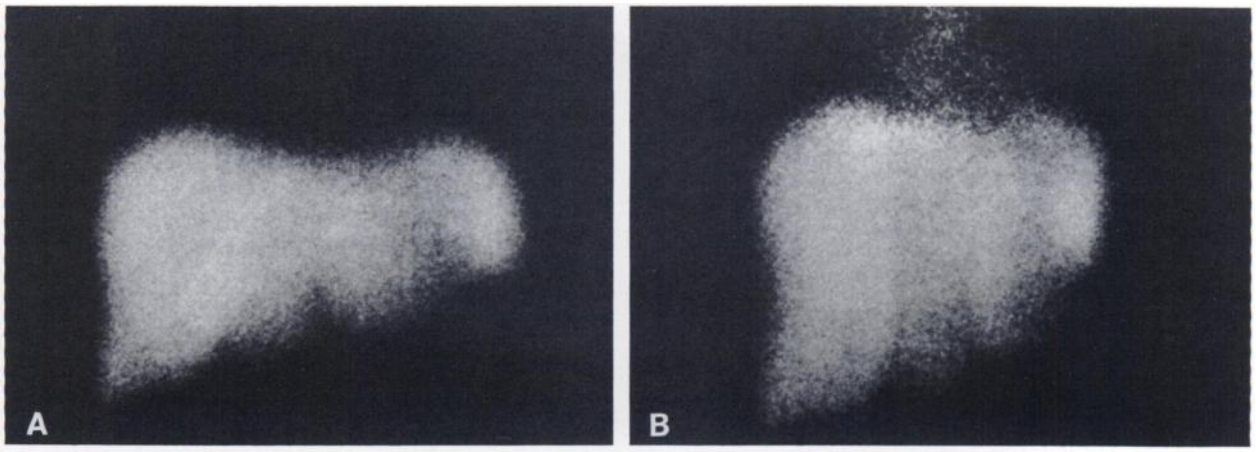

FIGURE 2
A: Supine. Liver with well demarcated caudate lobe. B: Erect. Right, caudate and left lobes have all increased by close to 50%

being compared with a previous study. We have standardized our own operation to some extent by indicating whether a study was performed in supine or erect position, and attempting to match the previous method when performing serial studies.

We have also observed, and it has been recently reported (*3*) that the upright view often reverses or accentuates the reversal of the normal liver-spleen ratio. Colloid shift and hepatomegaly are both indicators of diffuse parenchymal dysfunction. In a clinical setting, a borderline abnormality of either of these parameters is given greater credence if the other is abnormal. This further emphasizes the importance of an accurate assessment of hepatic size when performing upright views.

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