uptake of iodine in metastases and thyroid bed. However, from our experience as well as others (*1*) this value may range from 2 to 10% of the injected dose. On this assumption, the amount of iodine left on the sixth day post injection can be easily calculated and will range from 10 to 50 μCi. Moreover, all of this will be localized in thyroid bed and metastases. The amount of technetium present at the time of scan can also be computed as follows: In a normal thyroid, the pertechnetate uptake at ½ hr ranges between 1 and 3% of the injected dose. Therefore this value cannot be expected to be more than 1% for a person whose thyroid has been removed. Also, if this value is higher than 1%, then correspondingly the 24-hr uptake for iodine will be expected to be higher than the postulated 10%. Thus the amount of technetium present at the time of scan will be in the range of 50 μCi or less which is of the same order as the amount of iodine present on the sixth day. The result of this large amount of iodine present (even if one takes lower limit 10 μCi) will be to degrade the resolution of the collimator badly because of (A) the scattered contribution of iodine gamma rays [which incidentally is worse in the range of technetium gamma rays (*2*)] and (B) the increased septal penetration of iodine gamma rays for a low-energy collimator. The evidence of this degradation in resolution is present in their technetium scan. Compare the size of metastasis denoted by C in their Fig. 1 with Fig. 2. The size in Fig. 2 is twice as big as in Fig. 1. The likelihood that this metastatic lesion has grown twice its size in 5 days is remote. We feel that this is due to degradation of the resolution of the collimator. If now one applies this degradation of resolution on lesions A, B, D, and E, and the large amount of activity in the heart blood pool, one will obtain a scan of Fig. 2. Therefore, one cannot blame the high blood background alone as the probable cause for not seeing the metastatic lesion E.

RAMESH CHANDRA
JOSEPH HERNBERG
PHILIP BRAUNSTEIN
New York University Medical Center
New York, New York

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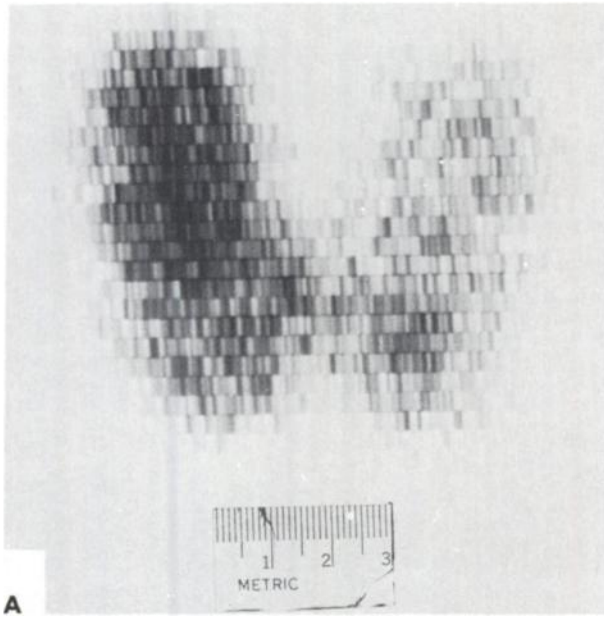
THE AUTHORS' REPLY

The case we reported was obviously not part of a carefully planned study. We completely agree that a better procedure would be to perform the ^{99m}Tc-pertechnetate scan initially. This fact notwithstanding, the point made by our paper remains unchallenged. The point is that where thyroid uptake of ^{99m}Tc-pertechnetate is *low* (as in the case of a hypothyroid patient after thyroidectomy), a small island of remaining uptake may be "lost" in a sea of background radioactivity.

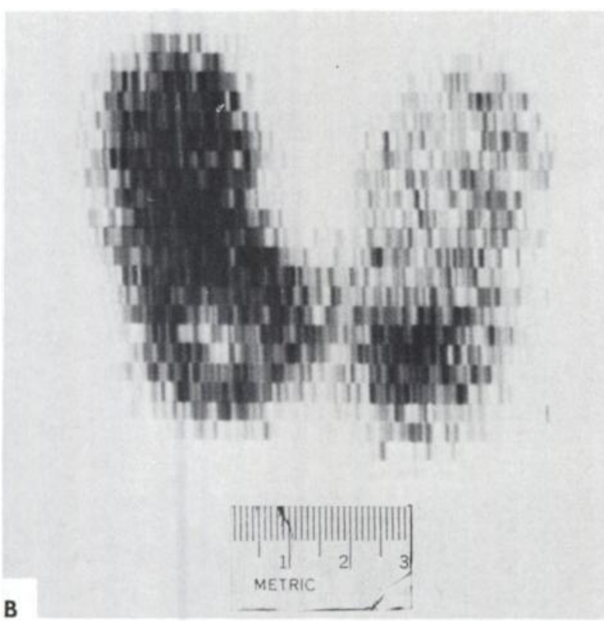
Because of space limitations we will agree that on Day 5 an equal number of microcuries of ^{131}I and ^{99m}Tc will be found in the various lesions 30 min after ^{99m}Tc-pertechnetate administration. In fact, there would probably be less ^{131}I due to the fact that ^{131}I is not only lost by physical decay but is also lost by biologic metabolism. Overlooked by Chandra et al is this latter process which would be accelerated in this patient due to the elevated TSH levels associated with hypothyroidism and also due to the fact that thyroid cancer has a more limited capacity to store ^{131}I in the form of thyroid hormone. Another point overlooked by the writers is that Fig. 1 shows the almost complete absence of radioiodine in the regions usually associated with the heart and great vessels. At 5 days post ^{131}I the amount of radioiodine in these areas would diminish even further. One obviously cannot claim to have scatter in these areas from nonexistent radioiodine.

Some review of basic physics appears to be in order. The counting rate of a given quantity of ^{131}I will fall by 75% or more if counted at the collimator focal point, using first an ^{131}I collimator and ^{131}I channel settings and then using a ^{99m}Tc collimator and ^{99m}Tc channel settings. This is due to the fact that counting rates tend to be much lower when counting Compton scatter than when counting at the photo peak (assuming equivalent window settings). Add to that the fact that the ^{99m}Tc photons have a higher efficiency of interaction with the sodium iodide crystal. Taken together, these facts yield the following: A given number of microcuries of ^{99m}Tc counted with a ^{99m}Tc collimator on the ^{99m}Tc channel will yield approximately a tenfold higher counting rate than an equal number of microcuries of ^{131}I counted under the same circumstances. Thus the contribution of ^{131}I counts to Fig. 2 (see original paper) over the areas visualized in Fig. 1 is about 10%. As one moves away from these areas, the ^{131}I contribution to the counting rate falls away rapidly. There is no doubt



A

FIG. 1A. Scan of thyroid phantom containing 100 μCi of ^{131}I.



B

FIG. 1B. Scan of same thyroid phantom containing 100 μCi of ^{131}I and 100 μCi of ^{99m}Tc.

that the ^{131}I photons will not be collimated well, but the question to be asked is: to what degree will these few photons degrade the ^{99m}Tc image? We have one glaring clue—the lateral border of area C as seen in Fig. 2. It is crisp and clear. The image degradation of the ^{131}I photons cannot be discerned. The reason area C appears larger in Fig. 2 is that it lies in a sea of ^{99m}Tc activity and its other borders, therefore, are indistinct and cannot be discerned or measured. To assure oneself of this, merely measure the distance from the xiphoid landmark to the lateral border of area C. If one then makes similar measurements with the left supraclavicular region, as seen in Fig. 2, it becomes evident that the metastasis on the right side lies in a sea of background radioactivity.

To further illustrate the lack of image degradation of ^{131}I on the ^{99m}Tc scan (in equal microcurie amounts), a phantom was first scanned with 100 μCi of ^{131}I. The scan in Fig. 1A was done with an ^{131}I collimator similar to that used for the production of Fig. 1 (original paper) on the 364-keV spectrometer setting. The maximum counting rate was 140,000 cpm and the information density employed was 750 counts/cm^2. At the completion of the scan, the collimator was changed and a low-energy ^{99m}Tc collimator substituted, similar to that used in the production of Fig. 2. The spectrometer was changed to the 140-keV setting. The maximum observed counting rate was then 9,500 cpm, or a 93% loss in counting rate. One hundred microcuries of ^{99m}Tc were then added to the phantom, which already contained 100 μCi of ^{131}I. The observed maximum counting rate on the ^{99m}Tc channel (with the ^{99m}Tc collimator) was then 100,000 cpm. Note that the window settings for ^{131}I that we employ are somewhat wider proportionately than that used for ^{99m}Tc. A scan was performed with an information density of 750 counts/cm^2 (enclosed Fig. 1B). There is little evidence of image degradation, in fact, due to the superior collimation of the ^{99m}Tc photons, Fig. 1B is superior to Fig. 1A. The ^{131}I scatter contribution to the ^{99m}Tc scan is negligible. Measurements of length and width taken from Fig. 1B were almost identical to those of the original phantom itself.

Thus, it is evident that Fig. 2, as found in our paper, suffers little from higher energy photon degradation, and the major problem is still the one we addressed ourselves to—that of locating an area of low ^{99m}Tc uptake in a much larger sea of ^{99m}Tc. Let us hasten to point out that this case will only obtain when uptakes are low, since on other occasions, neck and chest thyroid metastases have been visualized employing ^{99m}Tc-pertechnetate. This case was presented to caution against thoughtless use of ^{99m}Tc-pertechnetate.

By the way, the answer to the question "Is It the Blood Background?" is YES.

H. J. DWORKIN
Chief, Nuclear Medicine
William Beaumont Hospital
Royal Oak, Michigan
J. W. MEIGAN
Naval Hospital
Camp Pendleton, California