RADIONUCLIDE PERFUSION OF HEPATIC METASTASES

Yeh and his colleagues recently reported (*J Nucl Med* 14: 565–567, 1973) their experience with intravenous perfusion hepatography using ^{113m}In eluate in the differential diagnosis of hepatic masses shown by ^{99m}Tc-sulfur colloid scintiphotography.

For the past 2 years we have been using a similar technique to evaluate hepatic and perihepatic masses. Instead of ^{113m}In eluate, however, we have been using 10 mCi of ^{99m}Tc-pertechnetate to perform the dynamic phase of the study.

In all of Yeh's 21 metastatic tumors of the liver, the perfusion of defects present on the colloid liver scan was reduced in radioactivity when compared with the hepatic parenchyma. We agree that the majority of metastatic lesions appear to have reduced perfusion on the dynamic study, but occasionally we have found a secondary liver neoplasm to be perfused as well as that of the surrounding hepatic parenchyma. In our 34 cases of proved metastatic lesions to the liver, we have found two metastases to have perfusion equal to that of the surrounding parenchyma. One case was malignant melanoma metastatic to the liver. The other patient had an adenocarcinoma metastatic to the liver from the adrenal gland.

Thus, in addition to hepatomas and hemangiomas, we have found that metastatic neoplasms may be well perfused when compared with the surrounding hepatic parenchyma.

JOHN F. ROCKETT
JOHN S. BUCHIGNANI, JR.
Baptist Memorial Hospital
Memphis, Tennessee

THE AUTHORS' REPLY

We agree with Rockett's statement about good perfusion occasionally seen in hepatic metastases and have noted this from the literature (*1,2*). A remark in this regard has been made in the discussion of our paper as follows: frequently, hepatoma is highly vascularized whereas cholangioma or metastatic tumor is much less vascular. However, we did not encounter hepatic metastases with good perfusion, nor melanoma metastatic to the liver, nor hepatic metastasis from adenocarcinoma of the adrenal gland in our study.

SHIN-HWA YEH
WEI-JEN SHIH
JYH-CHWEN LIANG
Veterans General Hospital
Taipei, Taiwan

REFERENCES

1. SUZUKI T, SARUMARU S, KAWABE K, et al: Study of vascularity of tumors of the liver. *Surg Gynecol Obstet* 134: 27–34, 1972

2. SUZUKI T, HONJO I, HAMAMOTO K, et al: Positive scintiphotography of cancer of the liver with ^{67}Ga-citrate. *Am J Roentgenol Radium Ther Nucl Med* 113: 92–103, 1971

INTESTINAL ABSORPTION OF PERTECHNETATE: CALCULATION BY THE ORAL/INTRAVENOUS PLASMA ACTIVITY QUOTIENTS AND INVERSE CONVOLUTION METHOD

The recent article by Hays (*1*) dealt with, among other subjects, the intestinal absorption of pertechnetate. This absorption was determined as follows: one dose of $^{99m}TcO_4^-$ was administered intravenously on one session and another orally in a later session. The time course of plasma activity was followed each time for 2 hr. Absorption was evaluated as the ratio of the relative plasma activity after the oral administration to that at the same time after the intravenous dose of the tracer. Some of the absorption estimates gave values coming up to 149.3% of the oral dose (Table 1, Ref. *1*). This indicates an error inherent in the method. These reported data prompted us to report our approach to the measurement of pertechnetate absorption and to point out a probable source of the error.

In our approach, intestinal absorption was evaluated in two patients. After an overnight fast, each received about 500 μCi $^{99m}TcO_4^-$ orally. After 3 days, each was given about 250 μCi of this tracer intravenously. Blood was taken at 10, 20, 30, and 45 min, and 1, 1.5, 2, 3, and 4 hr both after oral and intravenous administration of the tracer. Technetium-99m activity in 1.00-ml samples of plasma and of

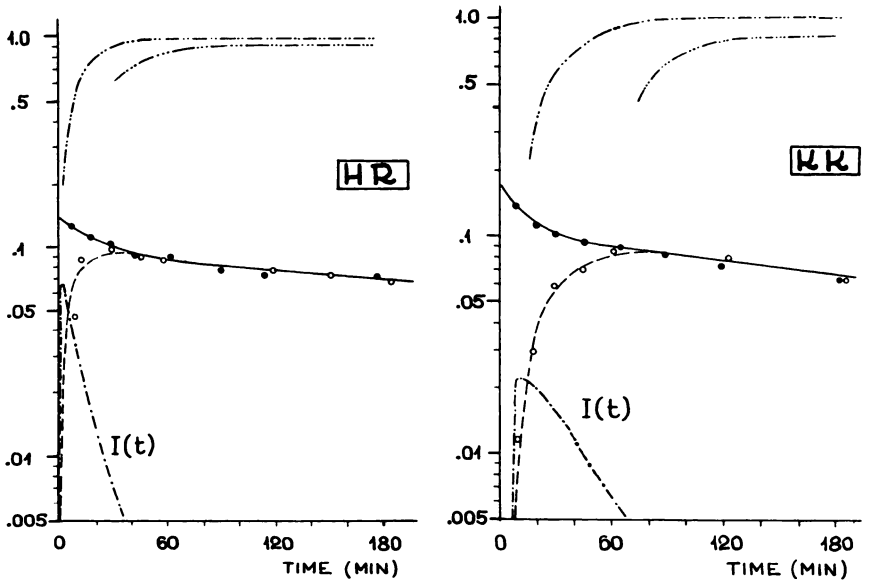

FIG. 1. Time course of plasma concentration, expressed as fraction of dose per liter, of oral o - - - o and intravenously administered ●——● pertechnetate. Function I(t) is absorption rate of tracer, expressed as fraction of dose per min. Time course of Hays' ratio is represented by - • • - while that of equilibrium ratio is expressed by - • • • -.

TABLE 1. COMPARISON OF FRACTIONAL ABSORPTION OF PERTECHNETATE CALCULATED IN THREE WAYS

	Way of calculation				
Patient	Integral of I(t)	Equilibrium ratio	Δ (%)*	Hays ratio	Δ (%)*
HR	0.975	0.958	−1.74	0.999	+ 4.20
KK	0.905	0.827	−8.62	0.997	+10.17

* Compared to the integral of I(t).

appropriately diluted standards was measured with a 3 × 3-in. NaI(Tl) probe. All data corrected for decay were expressed as fractions of the dose per liter plasma. Plasma activity curves after oral and intravenous dose of the tracer were fitted by the method of least squares with three and two exponentials, respectively.

To determine the appearance rate of orally administered $^{99m}TcO_4^-$ in the blood plasma, we applied the convolution integral (*2*)

$$G(t) = \int_0^t I(\tau)F(t-\tau)d\tau$$

in which G(t) corresponds to the plasma activity curve after oral dose of the tracer at time $t_0 = 0$, F(t) is the plasma activity curve after intravenous dose of the tracer at time $t_0 = 0$, $I(\tau)$ is the rate of intestinal absorption of the oral dose, and τ is a dummy variable of integration. The inverse of this integral, deconvolution, was calculated according to a method previously described (*3*). All the calculations were carried out using a CDC 3170 computer. Both the experimental curves, G(t) and F(t), and the computed functions, I(t), are shown in Fig. 1. Absorption rates for $^{99m}TcO_4^-$ attained maxima at 3 and 10 min, and absorption was essentially complete (about 90%) by the time the plasma activity after the oral dose attained its peak value, i.e., within 32 and 76 min, respectively.

The fractional absorption of pertechnetate was calculated in three ways: by numerical integration of the function I(t) (*3*), by the equilibrium ratio of oral/intravenous plasma activity of the tracer (*3*), and by the ratio proposed by Hays (*1*). The results are given in Fig. 1 and Table 1.

The equilibrium ratio method depends on the assumption that the intravenous dose of a tracer is not given until after absorption of the oral dose is essentially concluded. Thus the plasma activity curve after the intravenous dose should be shifted more to the right in relation to the plasma activity curve after the oral dose the later the peak activity of the latter occurs. The error is negligible when the interval between the conclusion of absorption of the oral dose and administration of the intravenous dose is small. Otherwise the method is not accurate. Thus the estimation of absorption by the ratio of the plasma activity after the oral dose to the plasma activity at the same experimental time after the intravenous dose (*1*) has to result in an overestimate of absorption.

The oral/intravenous ratio can be as reliable as the inverse convolution method provided the last exponents are taken for calculation (*3*). But this requires sampling of blood over at least 2 days since the half-time of the last exponent is about 50 hr (*4*).

J. SZYMENDERA
MARIA RADWAN
Institute of Oncology
Warsaw, Poland

REFERENCES

1. HAYS MT: ^{99m}Tc-pertechnetate transport in man: Absorption after subcutaneous and oral administration; secretion into saliva and gastric juice. *J Nucl Med* 14: 331–335, 1973

2. BERKOWITZ JM, SHERMAN JL, HART HE: The rate of decarboxylation of mevalonic acid-1-C^{14} in man. *Ann NY Acad Sci* 108: 250–258, 1963

3. SZYMENDERA J, HEANEY RP, SAVILLE PD: Intestinal calcium absorption: Concurrent use of oral and intravenous tracers and calculation by the inverse convolution method. *J Lab Clin Med* 79: 570–578, 1972

4. LATHROP KA, HARPER PV, HINN GM, et al: Biological fate of technetium in mammals. *Radiat Res* 25: 210, 1965

THE AUTHOR'S REPLY

Szymendera and Radwan correctly point out that measurement of intestinal absorption by the isotopic ratio method leads to overestimate, particularly when the material studied has a short half-life. As stated in my paper, "This technique causes overestimate of absorption percentage because of the rapid early disposal of a portion of the intravenous dose. The ratio technique was adopted here because of its simplicity. It was felt that the systematic error introduced by this approach is small and should not affect comparative studies."

The elegant analysis which Szymendera and Radwan have applied to their data certainly improves the accuracy of estimate of intestinal absorption. However, the method used in my paper is much less cumbersome, does not require the use of a digital computer, and, I believe, adequately demonstrates the fact that intestinal absorption of pertechnetate varies markedly in extent and timing.

MARGUERITE T. HAYS
Veterans Administration Hospital
Buffalo, New York

REDUCTION OF THE EFFECTS OF SCATTERED RADIATION

In their article on the reduction of the effects of scattered radiation on a sodium iodide imaging system (*J Nucl Med* 14: 67–72, 1973) Bloch and Saunders state that they obtain improvement of the modulation transfer function (MTF) of a rectilinear scanner and a gamma camera by simply subtracting the number of counts recorded in the Compton energy interval 91–102 keV from the number of events simultaneously recorded under the photopeak 125–170 keV.

Improvement of the MTF may be expected when the ratio between the number of unscattered photons and the number of scattered photons in the observed energy interval 125–170 keV is changed in favor of the unscattered photons. This ratio does not change by simply subtracting the gross counting rate in the energy interval 91–102 keV from the gross counting rate in the interval 125–170 keV. Therefore the results of Bloch and Saunders are difficult to understand.

P. INIA
Klinisch Chemisch Laboratorium
Leeuwarden, The Netherlands

THE AUTHORS' REPLY

There is, we think, a simple reason why the scatter subtraction technique improves the spatial resolution. The figure (right) shows the counting rate as a function of position for a line source of ^{99m}Tc surrounded with scattering material, separated into a "geometrical" component due to gamma rays emitted within the collimator field of view and a "scatter" component due to scattered photons recorded within the photopeak window 125–170 keV. At distance x_1 from the line source most of the measured events are due to scattered photons. Our calculations

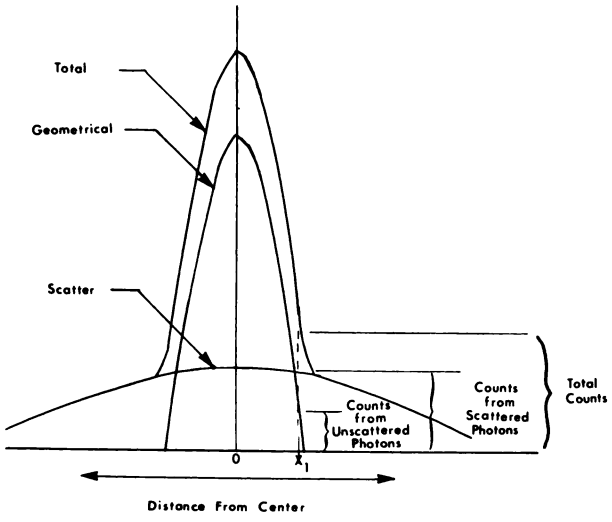

FIG. 1. Measured counting rate of line source separated into "geometrical" component due to gamma rays emitted within collimator field of view and "scatter" component due to scatter photons recorded within photopeak.