

clinicians, a brief review is certainly of interest to those not likely to be familiar with them. Drs. Wait and Movahed should remember that mixed forms of edema may occur (7), confounding some of the clinical information.

Regardless, Drs. Wait and Movahed are correct in stating that pulmonary scintigraphy in pulmonary edema should not be applied and billed to patients without further investigation about its utility. In the article under discussion, I suggested with Dr. Higgins some interesting clinical avenues of research, I am quite content to stand on that little isolated portion of the aforementioned "cornfield."

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Robert A. Slutsky
University of California Medical Center
San Diego, California

Brain Tumor Imaging Using C-11-Labeled L-Methionine and D-Methionine

TO THE EDITOR: Positron emission tomography (PET) allows the characterization of local brain function in normal and pathological states (1-4). Carbon-11-labeled amino acids, DL-valine, DL-tryptophan, and aminocyclopentane carboxylic acid have been used to image brain tumors (5,6). In a case report, Bergström et al. (6) demonstrated differences in the imaged size of a brain tumor by CT and PET, using Ga-68 EDTA, C-11-glucose, and C-11 L-methionine. From in vitro studies with an amino acid analyzer (7) and from nutritional support studies (8), it is known that methionine provides especially high tumor-to-nontumor ratios in gliomas and metastatic brain tumors.

In preliminary in vivo studies of brain tumors with C-11-

labeled L- and D-methionine, we have also found significant uptake ratios with both isomeric forms. Production of C-11-labeled D- and L-methionine is described elsewhere (9). The D and L forms were analyzed for optical purity. Seven patients with brain tumors and without previous treatment were studied, each of them providing informed consent to the protocol. PET scans were performed with a positron camera 20 min after i.v. injection of 30 mCi of tracer, when the blood level is sufficiently low (5). Up to nine slices of 1.6-cm thickness were reconstructed. The diagnosis was ascertained clinically and by angiography, CT, and NMR, and histologically in six of the seven patients. Relevant details and PET findings are given in Table 1.

In two patients with disruption of the blood-brain barrier (BBB) according to scintigraphic findings with Tc-99m DTPA, no significant methionine uptake could be found. In one patient with a grade 1 astrocytoma I, an uptake of C-11 L-methionine occurred, but no BBB breakdown could be verified. The regional uptake ratio of tumor-to-contralateral tissue increased with tumor grade and was highest in a grade 4 astrocytoma. The accumulation of the L form is slightly higher than that of the D form in most cases. A sample PET image is shown in Fig. 1.

Generally the uptake of C-11-labeled methionine may be due to BBB breakdown and/or incorporation into the protein fraction of tumor tissue. Our preliminary findings suggest that the accumulation is not governed by BBB breakdown but that at least a considerable fraction of the accumulation is due to an active metabolic process. The high uptake of D form methionine, which hitherto had not been observed, seems to indicate that the metabolic process is quite unselective and that it may provide a measure for the degree of malignancy of the tumor. If this holds true, quantification of this phenomenon could be helpful in the grading of brain tumors.

Quantification models for in vivo amino acid metabolism in the brain have been developed by Phelps et al. and Bustany

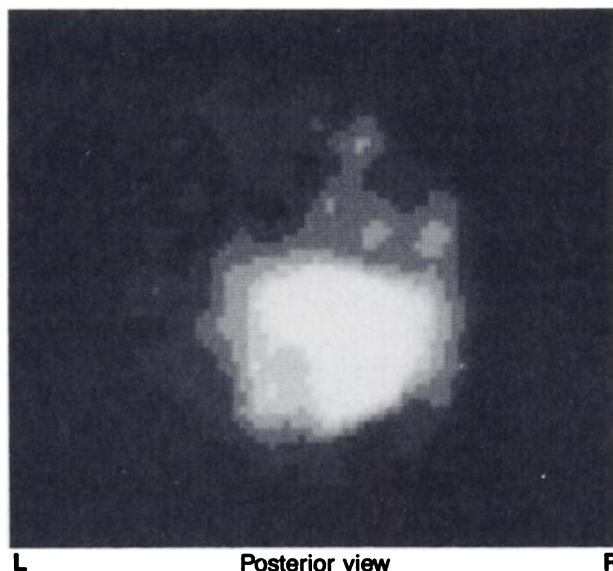


FIGURE 1
PE tomogram of C-11 L-methionine uptake in astrocytoma IV (4 X 5 cm) in right occipital lobe close to midline.

TABLE 1
Patient Population and Regional Uptake Ratio of Tumor to Contralateral Normal Tissue

Patient	Age	Sex	Ratios of tumor to contralateral normal brain tissue: C-11 methionine		Diagnosis
			L-	D-	
1*	21	F	1.01	0.98	calcified microangioma
2*	58	M	1.28	1.28	metastatic brain tumor
3†	39	M	1.40	1.30	Grade 1 astrocytoma
4	63	M	1.86		metastatic brain tumor
5	33	F	1.88	1.50	meningioma
6	59	F		1.82	glioblastoma
7	60	F	2.40	2.60	Grade 4 astrocytoma

* Blood-brain barrier (BBB) break down in Tc-99m DTPA image.
† No BBB break down.

(10). However, using S-methyl-labeled C-11 methionine, the problem of trans- and demethylation has to be taken into account, e.g., by chromatographic analysis of plasma constituents. It remains questionable whether either of these models can be applied to pathological states where BBB breakdown must be considered. We are currently working on the development of a procedure to differentiate accumulation by BBB breakdown from other active processes, by measurement of such factors as blood volume, perfusion, and free diffusible volume of brain tumors.

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Otmar Schober
Geerd-J. Meyer
Dietmar Stolke
Heinz Hundeshagen
Medical School Hannover
D-3000 Hannover 61, West Germany

New Perspectives in Localizing Enlarged Parathyroids by Technetium-Thallium Subtraction Scan

TO THE EDITOR: Ferlin et al. (1) have introduced a very practical and beneficial method for parathyroid localization by technetium-thallium subtraction. We applied this method to 18 cases with a few modifications and our results were quite satisfactory.

In our studies we used 500 µCi of technetium and 2 mCi of thallium. After acquiring an initial technetium image of 50k counts in 128 × 128 × 16 matrix, we acquired 2 static thallium images of 50k counts each in the same matrix beginning 2 min after injection.

After completing the study in the classical anterior position, we repeated the study in the right and left anterior oblique positions to obtain a better view of the posterior surface of the thyroid. An example is seen in Fig. 1, where the image obtained in the left anterior oblique position displayed the intrathyroidal parathyroid adenoma more precisely than the image obtained in the anterior position. Surgery revealed a parathyroid adenoma embedded in the left lobe extending to its upper pole which was similar in shape and location to the image obtained in the left oblique position.