Bilateral Subdural Hematomas Diagnosed with Technetium-99m-HMPAO Brain SPECT

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An elderly patient with a complex history of organic dementia but a normal neurologic examination had a ^{99m}Tc-hexamethylpropylene-amine-oxime (HMPAO) brain scan for a suspected cerebrovascular accident or space-occupying lesion. The study showed no perfusion abnormality in the brain parenchyma, but bilateral flattening and inversion of the normal hemispheric convexities, with separation from the skull was identified. Bilateral subdural hematomas (SDH) were suspected and the patient had a computed tomographic scan that confirmed the diagnosis.

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Scintigraphic agents that test the blood-brain barrier have been used to diagnose chronic and, to a lesser extent, acute subdural hematomas (*1,2*). Dynamic and static images in combination have been recommended to achieve the greatest sensitivity (*2,3*). This technique has largely been replaced by computed tomography (CT), which has a greater sensitivity and specificity (*2,4*).

New single-photon emitting agents, such as ^{99m}Tc-HMPAO demonstrate relative cerebral blood flow (*5*). They also allow for SPECT imaging and are being used increasingly to study disease processes that may alter blood flow. Specifically, ^{99m}Tc-HMPAO brain SPECT has been used in investigating cerebrovascular disease, focal epilepsy, dementias, tumors, and head trauma (*6–10*).

Other pathologic or physiologic processes may be evident and should be recognized (*10*). We report a patient in whom bilateral subdural hematomas were diagnosed using ^{99m}Tc-HMPAO SPECT.

CASE REPORT

A 70-yr-old man was referred for brain scintigraphy from another hospital. His history included three recent falls, preceded by dizziness and palpitations. He had been seen twice in an emergency service and no abnormality was found. He was a non-insulin dependent diabetic on glyburide (5 mg daily). Upon admission to the hospital following the third fall, he was complaining of back pain and was found to be pale, hypovolemic, and pancytopenic. Neurologic examination was again normal as were other tests. On the second day of hospitalization, mild weakness and hyperreflexia was noted in his left arm and on Day eight he became slightly confused. The possibility of a cerebrovascular accident or space-occupying lesion was raised. Neither a CT scanner nor a nuclear medicine service were available at this hospital and the patient was referred for HMPAO brain SPECT.

Tomographic images revealed uniform brain activity (Figs. 1 and 2). The striking finding, however, was bilateral flattening and inversion of the hemispheric convexities away from the skull (Figs. 1 and 2). The abnormalities extended near to the midline on both sides but did not cross it. The parietal, frontal, and to a lesser extent, the temporal and occipital lobes were involved, with the degree of abnormality being much more extensive on the left side.

The diagnosis of bilateral subdural hematomas (SDH) was suggested (although the findings on the right were much less certain) and after consultation with the referring physician a CT scan was performed. This clearly demonstrated an acute chronic SDH on the left, associated with moderate mass effect (Fig. 3). On the right side, a subacute SDH was seen, confirming the diagnosis of bilateral SDH (Fig. 3). The patient had bilateral craniotomies and evacuation of the hematomas, followed by an uneventful recovery and was well up to 6 mo after treatment.

Since this report was prepared we have had a second patient referred for investigation suspected of having a cerebrovascular accident. The findings were similar and CT again has confirmed a diagnosis of bilateral SDH.

DISCUSSION

SDH, especially if chronic, can be a difficult diagnosis to make (*11*). Trauma is the most common cause, but it can be minor and is often forgotten (*11,12*). Hematomas are thought to result most often from the disruption of bridging veins that cross the subdural space, although a small percentage are arterial in nature (*13*). Bilateral SDH are noted about 10%–20% of the time (*12*).

CT scanning is the best way to make the diagnosis of SDH (*4*). This technique demonstrates the SDH directly, although bilateral isodense SDH may occasionally be missed by this method, but will be detected by brain scanning using ^{99m}Tc-chelates (*2,14*). Indirect evidence of SDH, such as a mass effect or other complications of trauma, can also be easily detected on CT (*4,15*).

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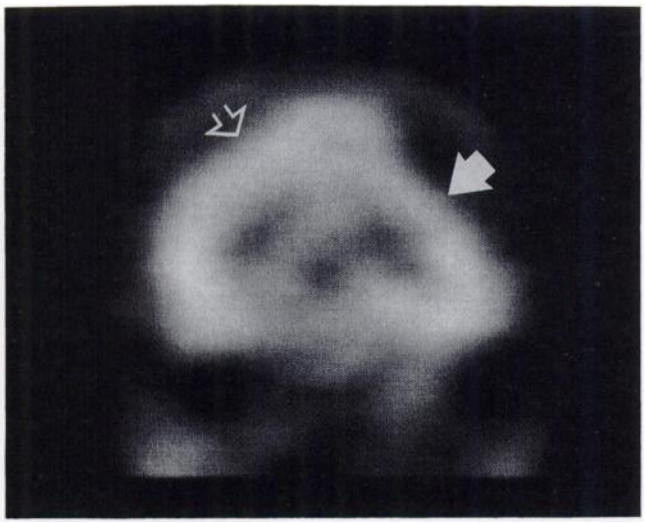

FIGURE 1. Coronal HMPAO SPECT image reveals marked left-sided flattening and inversion of the hemispheric convexity (large solid arrow) along with similar more subtle findings on the right (small open arrow).

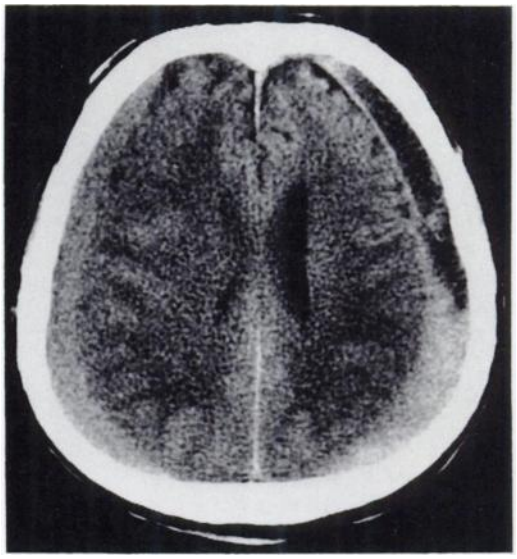

FIGURE 3. Contrast-enhanced CT scan providing evidence of a left-sided acute on chronic subdural hematoma and right-sided subacute subdural hematoma.

Agents that demonstrate relative cerebral blood flow might not be optimal for use in diagnosing SDH. The lesions are extra-axial and since minimal uptake of tracer would be expected, direct evidence of SDH will not be found. However, in patients such as this who are being investigated because of an organic dementia, SDH should not be overlooked since it is a treatable disorder.

In this report, a diagnosis of bilateral SDH was made using indirect evidence found on ^{99m}Tc-HMPAO SPECT. The findings were not unlike those seen on conventional dynamic images using ^{99m}Tc-chelates, namely photopenia in the area of the hematoma itself and displacement of adjacent structures. Some differences were noted however. First, on HMPAO brain SPECT, there is a significant amount of activity within the brain parenchyma defining its margin. Secondly, minimal activity is seen in the scalp and skull with poor definition of this margin. The sensitivity and specificity of such findings are unknown. When such findings are present, we suggest that correlation with CT scanning is necessary to exclude SDH.

This patient also illustrates the need to relate studies of function (in this case relative cerebral blood flow) to morphologic constraints (in this case displacement of brain substance by hematomas).

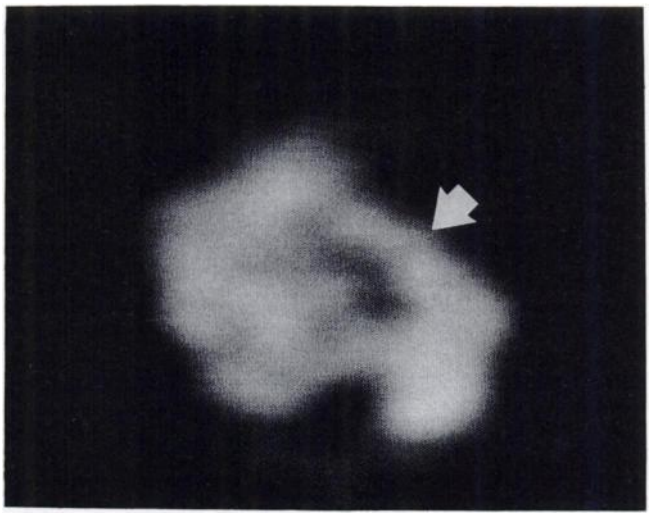

FIGURE 2. Corresponding left sagittal image clearly demonstrating the striking contour abnormality on this side (solid arrow).

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15 30

Selected manuscripts from the issues of *The Journal of Nuclear Medicine* published 15 and 30 years ago.
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Editorial: Radiochemical Purity of New Radiopharmaceuticals

William C. Eckelman

Because of the carrier-free nature of the popular radionuclides, most radiopharmaceuticals cannot be studied by ultraviolet or infrared spectroscopy, nuclear magnetic resonance, or elemental analysis. Accordingly, chromatography has become the major analytic tool for determining the radiochemical purity of a radiopharmaceutical. However, the term "radiochemical purity" is much abused. The strict definition is the percentage of the radionuclide in question in the desired chemical form. The common mistake is to use a chromatographic system that can only separate one radiochemical impurity and then to report the radiochemical impurity on that basis. This is especially evident for ^{99m}Tc radiopharmaceuticals, which are often stated to be pure after analysis for pertechnetate. The cause of this misinterpretation is not clear: certainly pertechnetate is the obvious impurity in ^{99m}Tc radiopharmaceuticals, but as early as 1967 another impurity, variously called reduced unbound ^{99m}Tc or reduced hydrolyzed ^{99m}Tc, has been identified.

Because of the loose interpretation of "radiochemical purity", the conclusions of many articles have been difficult to interpret. Therefore, a set of guidelines are proposed to bring uniformity to the articles on new radiopharmaceuticals published in the *Journal.* To be reasonably sure that a radiopharmaceutical contains only the desired species, at least two chromatographic systems should be used, with either different solvents, different solid-phase supports, or both. The two systems used to assay for radiochemical purity should show a single band of radioactivity and possess a partition coefficient such that the new compound is neither freely eluted nor strongly absorbed. Requiring this sort of information for each new radiopharmaceutical will provide a rational basis for judging the usefulness of the radiopharmaceutical. It is always judicious to note that radiochemical purity is not an absolute but is based rather on the known impurities. Still another radiochemical impurity might be detected in a radiopharmaceutical thought to be pure by using a more sophisticated separation technique, but two appropriate systems are usually sufficient. These guidelines will only apply to the radiopharmaceutical in vitro, although pertinent in vivo data on radiochemical purity are certainly needed for a full explanation of the mechanism of action and will be strongly encouraged. ■

OCTOBER 1961

A Theoretical Evaluation of Brain Scanning Systems

Robert N. Beck

The fact that brain lesions and normal brain tissue tend to take up injected radioactive material to different degrees underlies all attempts to locate brain tumors with gamma ray detectors. Two fundamentally different collimated scintillation detector systems, responding primarily to photons produced in small diameter cylindrical regions through the head, have been successfully developed for this purpose. A systematic scan of the head by these detectors produced a two-dimensional mapping of the distribution of radioactivity.

The positron or 'conicidence' system responds primarily to simultaneously detected, oppositely directed, pairs of 0.511 MeV photons produced by positron annihilation in the cylindrical region between the detectors. In addition, a relatively small spurious response is due to the occasional detection of simultaneous but unrelated 0.511 MeV photons from outside the region.

The focusing collimator or "singles" system responds primarily to single photons, which come from a region the precise shape of which depends on many design parameters. Here we shall deal only with focusing collimators consisting of identical, round, tapered holes in hexagonal array having a common apex at the focal distance. In such a case, the region of response has a circular cross section of radius R at the focal distance and a hexagonal cross section, somewhat larger, near the collimator. In addition, some gamma rays from outside this region enter the detector by penetrating the collimator septa.

In order to compare these systems, it has been necessary to develop:

1. A criterion based on the statistical nature of count rate information, which depends on both detector sensitivity and the change in count rate over a tumor.
2. A theory of detector responses to distributed sources, which, for the focusing collimator system, takes into account gamma ray penetration of the septa.

Under the conditions previously discussed, it appears that focusing collimator systems can be designed for 0.511 MeV radiation that are superior to coincidence systems by factors of 2 to 10 (depending on resolution) for midline tumors. These factors increase for tumors not on the midline.

Making the further assumption of equal numbers of photons produced for all systems, the figure of merit for focusing collimator systems increases with decreasing gamma energy down to 0.200 MeV, the low-energy limit of this investigation. It can be generally concluded therefore that the advantages of low-energy gamma radiation for brain scanning have not yet been fully exploited. ■