

# Sequential Brain and Bone Imaging with <sup>99m</sup>Tc-Diphosphonate

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Both brain and bone imaging are often required in evaluating patients with suspected metastatic disease. This usually necessitates a delay of one to two days between the studies since <sup>99m</sup>Tc is routinely used in both procedures. This article describes a possible method of eliminating this time delay by utilizing <sup>99m</sup>Tc-diphosphonate as a sequential brain- and bone-imaging radiopharmaceutical. The results indicate that detection of intracranial lesions with <sup>99m</sup>Tc-diphosphonate compares favorably with pertechnetate cerebral imaging in the studies presented and it may be a suitable agent for sequential brain and bone imaging.

Technetium-99m-diphosphonate (1-hydroxy-ethylidene-1, 1-disodium phosphonate) is an ideal radionuclide for skeletal imaging (1, 2). The technique of skeletal imaging with diphosphonate compounds is well known and is not discussed in this paper. This paper is intended to relate our experiences with diphosphonate in the sequential scanning of the brain and skeletal system.

Fundamental properties of radioactive tracers for brain imaging include (A) the ability to be measured when administered in small quantities, (B) the emission of gamma rays which penetrate the skull and make possible the accurate spatial localization of the radionuclide by external radiation detectors, (C) they should remain in the blood stream for a sufficient time to permit demonstration of neovascularity, and (D) their distribution should result in a difference in concentration of radioactivity in the lesion and its surroundings.

## Materials and Methods

Stannous diphosphonate is obtained commercially in kit form, each vial containing 5.0 mg of diphosphonate and 0.5 mg stannous chloride. Technetium-99m-diphosphonate is prepared by the addition of 2 to 5 ml of <sup>99m</sup>Tc-pertechnetate solution to the vial and mixing thoroughly to dissolve the lyophilized materials.

A Searle Pho-Gamma III scintillation camera with the low-energy parallel hole collimator was used to obtain the cerebral blood flow and static brain images.

The patient is positioned beneath the detector of the

scintillation camera in the supine position so that the internal carotids and hemispheres of the brain are in the field of view of the detector. Approximately 15 mCi of <sup>99m</sup>Tc-diphosphonate is administered intravenously; preferably in the basilic vein. Four serial scintigraphs are obtained; the first of which is obtained as the tracer is seen in the carotids and the subsequent images are taken at intervals of approximately 3 sec.

Thirty minutes after completion of the dynamic cerebral flow study, conventional brain scintigraphy is performed of the anterior, posterior, and lateral views of the brain.

Delayed static brain images in the conventional views were obtained at the end of the skeletal scan to emphasize the differences of the brain imaging at 30 min postinjection (vascular) as compared to the images obtained at approximately 2 to 3 hr postinjection (skeletal).

## Results

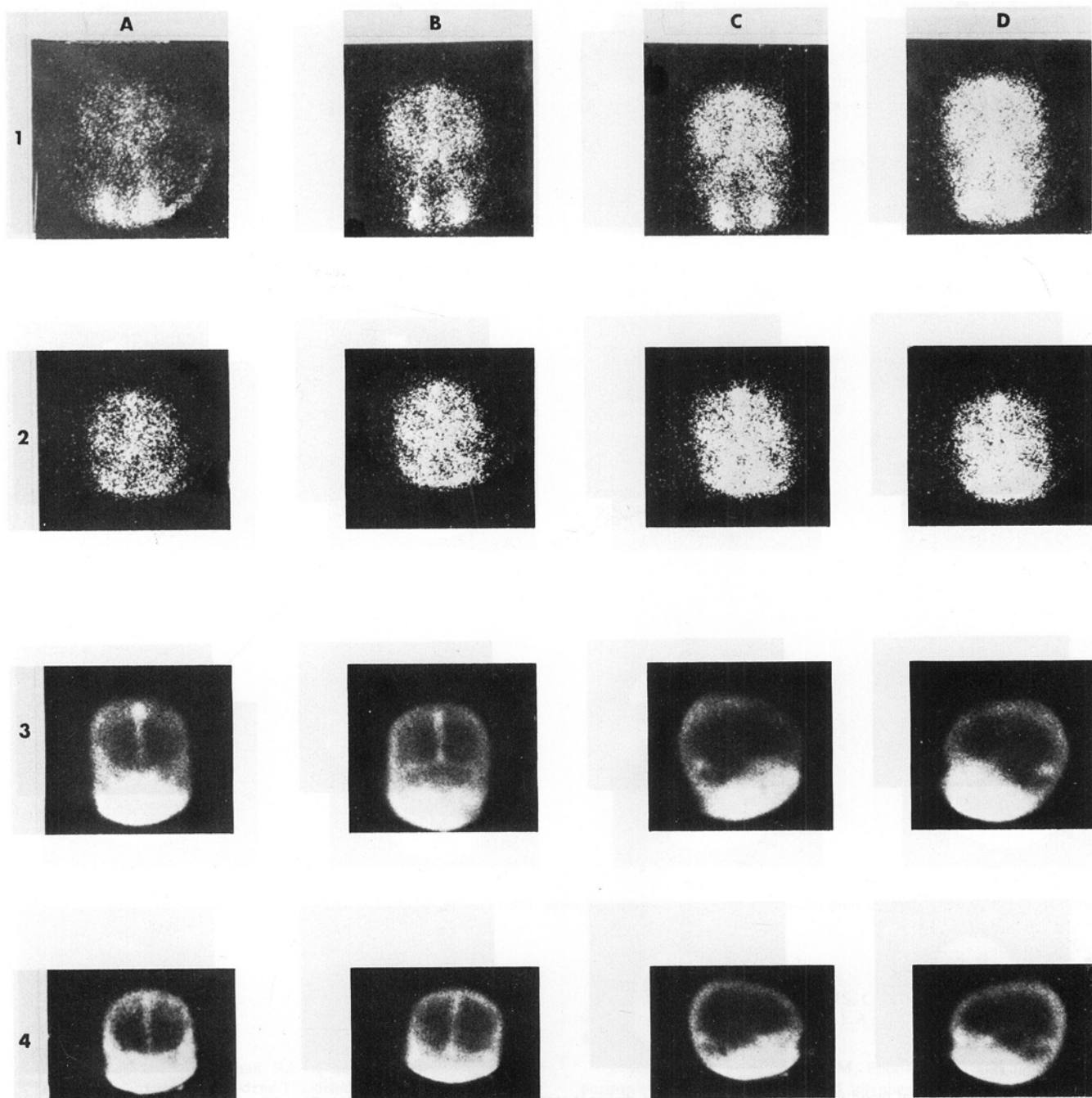
Cerebral brain scintigraphy utilizing <sup>99m</sup>Tc-diphosphonate was performed on 13 patients. Two of the cases illustrated demonstrate the comparison of pertechnetate and diphosphonate cerebral imaging at 30 min and one case depicts the comparison of delayed images with diphosphonate.

**Case I.** An 80-year-old male with cancer of the prostate had liver and bone scintigraphs read as normal. The cerebral blood-flow studies with pertechnetate and diphosphonate were also normal (Fig. 1). The scintiphotos taken at 13 sec show the tracer in the carotids and the anterior and middle cerebral arteries. The 16-sec view indicates good blood flow through the vasculature of the head. A good pattern of normal venous flow is seen with the display of the sagittal sinus in the 19- and 22-sec exposures. The static studies demonstrate no evidence of cerebral abnormalities and distribution of each tracer in normal areas of localization is similar.

**Case II.** A 58-year-old male was admitted in May 1973 with a malignant astrocytoma in the right cerebral

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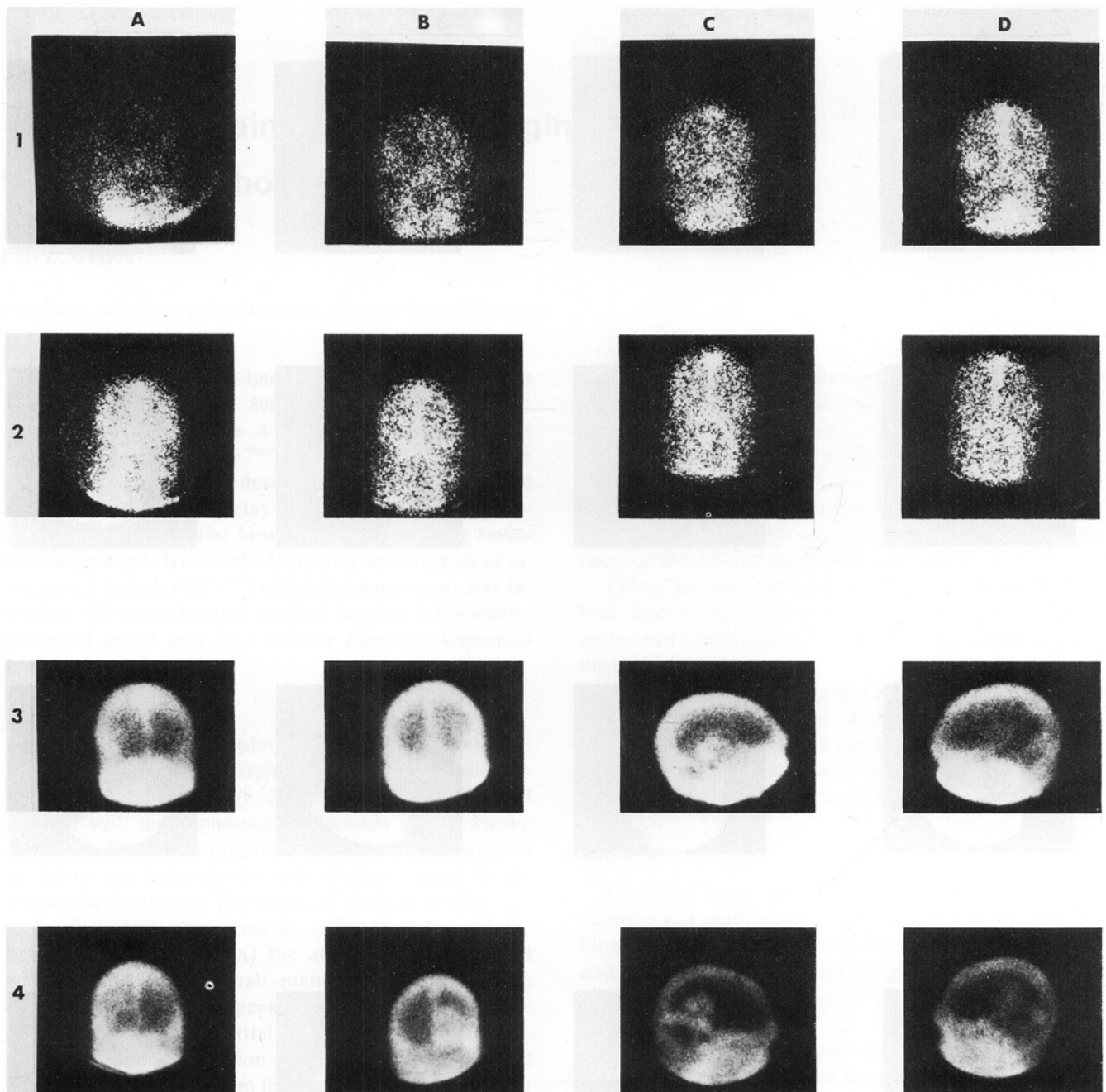
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**FIG. 1.** Normal cerebral blood flow with pertechnetate and diphosphonate is shown in 1 (A-D) and 2 (A-D) at 13, 16, 19, and 22 sec, respectively. Static views (ant., post., RL, LL) with pertechnetate and diphosphonate are shown in 3 (A-D) and 4 (A-D), respectively.

hemisphere, as established by a right temporal craniotomy. The chest radiographs revealed an infiltrate in the left upper lobe and the right carotid angiogram demonstrated a large hypervascular mass in the right temporal lobe of the brain. Pertechnetate cerebral imaging on May 2, 1973, demonstrated increased tracer transit through the left cerebral hemisphere as compared to the right (Fig. 2). The static study demonstrated focal increase in tracer localization in the right temporal lobe. On Sept. 7, 1974, the patient was re-

admitted to the hospital because of convulsions. Technetium-99m-diphosphonate cerebral imaging was performed on Sept. 16, 1974, and indicated increased localization in the right hemisphere when compared to the pertechnetate study. Bone imaging performed 2½ hr postinjection was read as abnormal. Increased tracer localization in the right hemisphere was observed on the bone scan. The patient died on Oct. 30, 1974, and no autopsy was performed. The final clinical diagnosis was CVA due to cerebral astrocytoma.



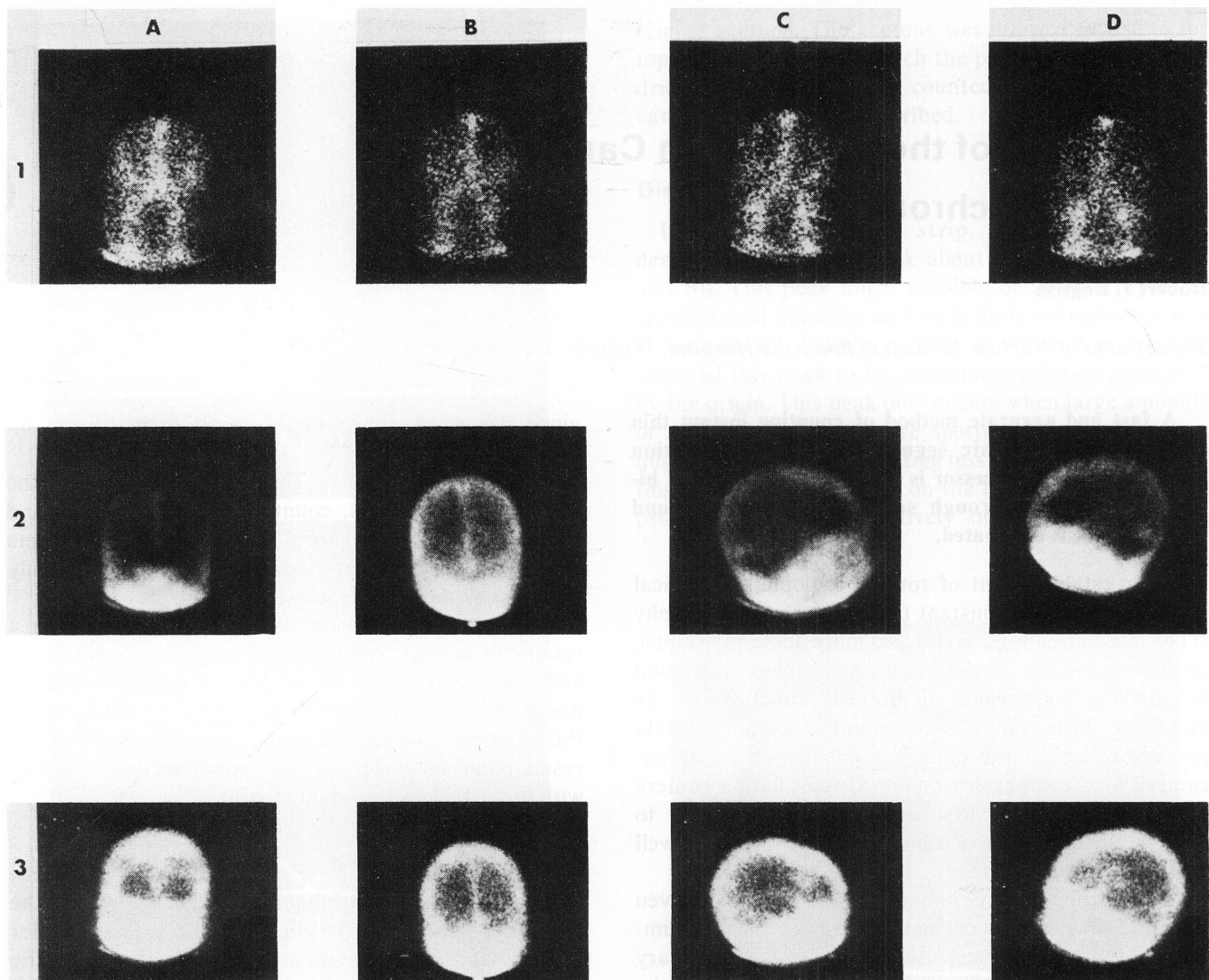
**FIG. 2.** Abnormal cerebral blood flow with pertechnetate and diphosphonate is shown in 1 (A-D) and 2 (A-D) at 13, 16, 19, and 22 sec, respectively. Static views (ant., post., RL, LL) with pertechnetate and diphosphonate are shown in 3 (A-D) and 4 (A-D), respectively.

**Case III.** A 53-year-old male had a right hilar mass. The 30-min diphosphonate cerebral imaging study was diagnosed as normal (Fig. 3). The delayed views at 2½ hr demonstrated increased localization of  $^{99m}\text{Tc}$ -diphosphonate in the cranial bone.

#### Discussion

Technetium-99m-diphosphonate in sequential brain

and bone imaging provides results of diagnostic quality when both studies are indicated. The diphosphonate cerebral flow study provides the same information as that obtained using pertechnetate. Diphosphonate remains intravascular (3) for a significant period of time to permit static cerebral imaging. These studies indicate that within 30 min to 1 hr static brain images obtained with diphosphonate are comparable to those obtained with pertechnetate.



**FIG. 3.** Normal diphosphonate flow is shown in 1 (A-D); normal static views in 2 (A-D); and increased localization of diphosphonate in bone after delay of 2½ hr in 3 (A-D).

## References

1. Castronovo FP, Callahan RJ: A new bone scanning agent: <sup>99m</sup>Tc labeled 1-hydroxy-ethylidene-1, 1-disodium phosphonate. *J Nucl Med* 13:823-827, 1972
2. Pendergrass HP, Potsaid MS, Castronovo FP: The clinical use of <sup>99m</sup>Tc diphosphonate (HEDSPA): A new agent for skeletal imaging. *Radiology* 107:557-562, 1973
3. Krishnamurthy GT, Tubis M, Endow JS, et al: Clinical comparison of kinetics of <sup>99m</sup>Tc labeled polyphosphate and diphosphonate. *J Nucl Med* 15:848-854, 1974

## Licensure Panel at Dallas ACNP Meeting

A scientific session with a panel discussion, "Nuclear Medicine Technologists—1976: Whither or Whether Licensure Legislation," will take place Saturday, June 5, 1976, at 1:00 p.m. in the Statler-Hilton Hotel in Dallas, TX. The session will be part of the annual Summer meeting program of the American College of Nuclear Physicians, and interested technologists are invited

to attend free of charge. The Section's President-Elect Mark Muilenburg will be a member of the panel and Dr. Hirsch Handmaker will serve as moderator. The licensure discussion should be of particular interest to technologists planning to arrive early for the 23rd Annual Meeting of SNM, which begins Monday, June 7.