Brain Scanning with ^{99m}Tc-citrate

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In 1941, Dickens reported that the concentration of citrate is higher in tissues with malignant tumors than in normal tissues. Following this theory, Benes et al. reported that if the scanning is performed by means of ^{99m}Tc-citrate, it accumulates in large amounts in malignant tumors, especially brain tumors, bone tumors or metastatic tumors. He concluded that ^{99m}Tc-citrate was useful to obtain these scans. We used a Solcocitran Kit that labels citrate with ^{99m}Tc-pertechnetate, and we wish to report the foudermental and clinical findings that we obtained. We were able to obtain ^{99m}Tc-citrate simply by mixing a vial of Solcocitran Kit and 1–5 m*l* of ^{99m}Tc-pertechnetate.

For purposes of foundermental study, we divided rats into 3 groups, and intravenously injected ^{99m}Tc-pertechnetate, ^{99m}Tc-DTPA and ^{99m}Tc-citrate into each respectively. We killed these rats a few at a time; some immediately after; some 15 minuits after; some 30 minuits after; some 1 hour after; some 2 hours after; and the remainder 3 hours after injection. Then we measured the rate of distribution of radiophermaceuticals in the blood, liver, pancreas, kidney, spleen and muscles of each rat, and measured the velocity of its disappearance in each organ. To discover the distribution of radiophermaceuticals in the organs we also made autoradiograms, killing rats at several intervals in time.

For clinical study, we performed brain scanning 30 minuits after injection of 20 mCi of ^{99m}Tc-citrate in 47 patients; including 15 patients with suspected brain tumor, 2 patients after surgery for brain tumor, II patients with suspected metastatic brain tumors and 19 other patients. Then we compared these with scanning by means of 20 mCi of ^{99m}Tc-pertechnetate. We were able to obtain clearer images of brain scanning with ^{99m}Tc-citrate than with ^{99m}Tc-pertechnetate. IN addition, we were able to obtain clearer and more useful images when the patients' tumors was located at the base of the brain, because little ^{99m}Tc-citrate accumulated in his salivary glands. In the case of children—The radiophermaceuticals usually accumulated in the chroid plexus because they can drink but little KCl, and comparatively speaking, ^{99m}Tc-citrate did not accumulate very much. This also one of the advantages of this phermaceutical.

We conclude and report that brain scanning, especially at the base of the brain, with ^{99m}Tc-citrate was very useful to diagnose brain tumors.

Clinical Utility of Brain Scan with ^{99m}Tc-EHDP

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Each of 80 cases, including patients who were examined more than once, was studied with two separate brain scans performed sequentially after the injection of 10–15 mCi of ^{99m}Tc-pertechnetate or 10–15 mCi of ^{99m}Tc-diphosphonate.

The resulting scans were qualitatively compared, and target-to-nontarget intensity ratio of each scan was determined.

A prospective study utilizing both ^{99m}Tc-pertechnetate and ^{99m}Tc-EHDP was undertaken to evaluate the recent observation that some cerebral infarctions are better defined with ^{99m}Tc-labeled phosphate complex than with ^{99m}Tc-pertechnetate and that reverse pattern may occur in cerebral tumors. Diagnoses were established by surgery, cerebral roentgen antiography or by clinical course. We examined 80 cases in this study, of which 46 were cerebral infarction, 24 were brain

tumor including meningioma (5), astrocytoma (1), glioblastoma (3), oligo dendroglioblastoma (1), acoustic neurinoma (3), secondary brain tumor (10), histological unknown (1), and other lesions which included A-V malformation with intracerebral hematoma (2), A-V malformation without intracerebral hematoma (2), subdural hematoma (1), brain abscess (1), giant cell tumor (1), secondary bone tumor (3).

The target-to-nontarget intensity ratio in cerebral infarction was greater with ^{99m}Tc-EHDP than with ^{99m}Tc-pertechnetate in 27 cases. In contrast to cerebral infarction, the target-to-nontarget intensity ratio was greater with ^{99m}Tc-pertechnetate than with ^{99m}Tc-EHDP in 14 cases.

In conclusion, these results indicate that this dual method is helpful in differentiating cerebral tumor from cerebral infarction.

Functional Image of Regional Cerebral Blood Flow (1) Method

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The functional imaging of the regional cerebral blood flow (rCBF) was developed using an Anger-type gamma camera and an on-line minicomputer system.

The data-processing system consists of an I/O unit, a CPU (16 KW), a MT, a typewritera nd a CRT display. The programs were written in an assembly language and stored in the initial 4K words of the core memory and the remaining 12K words were allocated to the images and the wash-out curves.

In this study, 3–5 mCi of Xe-133 in saline solution was injected rapidly into the internal carotid artery and 130 serial digitalized images of one second frames were stored on the MT. Hyperventilation, CO_2 inhalation and/or vascular compression tests, if necessary, were performed afterwards and the serial images after the repeated Xe-133 injection were also stored on the MT.

The data were processed as follows; For the first place, the processing area was set in the accumulated image displayed on the CRT. Then the wash-out curves in every 8 mm*8 mm element in the area were extracted from the serial images on the MT. The blood flow rates in every element were calculated as rCBF-initial (ml/100 g/min) using the least square method after the logarithmic conversion of the curves. The statistical errors due to the random nature of the radioactive decay were then calculated and expressed in standard deviations of the finally calculated values.

The calculated parameters were rearranged in the corresponding matrices and displayed on the CRT in a gray map. Type printings of them in 2 digitdecimal numbers in a map format were also carried out. The changes of rCBFs before and after the tests were also displayed and printed out in both absoluted differences and percent changes.

Functional Image of Regional Cerebral Blood Flow (2) Clinical Applications

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The clinical applications of rCBF functional image were performed in normal volunteers and 40 patients with intracranial disease.

The gamma camera was set at the skull. 5 mCi of Xe-133 in saline solution was injected into the internal carotid artery at rest and after each test