

EFFECTS OF RADIATION THERAPY ON BONE LESIONS AS MEASURED BY ^{99m}Tc-DIPHOSPHONATE

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Radiation therapy to bony metastases from an adenocarcinoma of the lung was followed by a measurable decrease in uptake of ^{99m}Tc-diphosphonate by the lesions.

The use of ^{99m}Tc-labeled radiopharmaceuticals for imaging organs offers numerous advantages over other radionuclides. Recently our laboratory developed a ^{99m}Tc-labeled bone imaging agent that has proven to yield consistently excellent bone scans (1,2). The agent ^{99m}Tc-labeled 1-hydroxy-ethylidene-1, 1-disodium phosphonate ^{99m}Tc-HEDSPA, or ^{99m}Tc-diphosphonate is an organic phosphonate compound that is chemically stable and nontoxic (3). The presence of ^{99m}Tc on the molecule has therefore opened new areas of research in conjunction with bone imaging. One such area lies in following the changes in uptake of ^{99m}Tc-HEDSPA by bone metastases before and after therapy. This potential has prompted our laboratory to investigate quantitatively these alterations in uptake in conjunction with a Nuclear-Chicago CDS 4096 multichannel analyzer. This paper is presented to report the initial results with one patient and to mention several thoughts for future studies.

MATERIALS AND METHODS

Our initial study was carried out in an adult white man (MGH #1670755) who had a bony metastases from an adenocarcinoma of the lung to the spine and to the ribs. Before therapy he was injected with 10 mCi of ^{99m}Tc-diphosphonate, and a whole-body rectilinear scan was performed with an Ohio-Nuclear dual 5-in. rectilinear scanner approximately 4 hr after injection (3). Multiple areas of increased uptake were observed in the cervical, thoracic, and lumbar spine and in a left lower rib, a finding consistent with bony metastasis (1). A portion of the spine including the abnormal rib was then imaged with a gamma

camera. These data were digitized, stored, and then transferred to magnetic tape using a commercial data-processing accessory (Nuclear-Chicago, CDS-4096) interfaced with the camera. At the end of the study the stored images were recalled from the magnetic tape and analyzed quantitatively on the CDS-4096. Normal and abnormal regions of interest were selected in the spine and the ribs to provide a relative measurement of the concentration of ^{99m}Tc-diphosphonate. The counts in each region of interest were determined by the Integrate Process Mode of the CDS-4096. These data were then normalized relative to a constant region of interest and expressed as the ratio of the counts in the bone lesion/counts in normal bone.

The radiation therapy included treatment three times per week into the involved rib and spine until approximately 3,000 R had been delivered over an 18-day period. At this time the patient had a repeat whole-body bone scan, and the quantitative procedure was repeated. The ratios obtained were then

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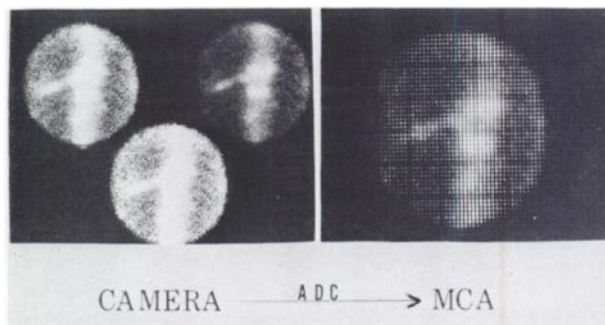


FIG. 1. Gamma camera and digitized views of posterior spine. Scan was performed 4 hr after i.v. administration of 10 mCi ^{99m}Tc-HEDSPA. (MGH #1670755). ADC—analogue-to-digital converter.

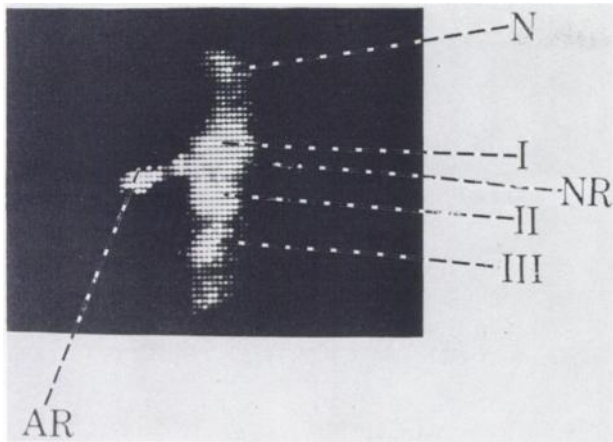


FIG. 2. Digitized view of posterior spine showing regions of interest. 1, 2, and 3 are spinal lesions. AR and NR are abnormal and normal ribs, respectively. N is normal spine.

compared with those values acquired during the pretherapy study.

RESULTS AND DISCUSSION

The analog gamma camera image of the posterior view of the spine and the resulting digitized view as observed on the oscilloscope of the CDS-4096 is illustrated in Fig. 1. The regions of interest selected for this study before and after therapy are illustrated in Fig. 2. Regions I, II, and III represent definite lesions in the spine: AR represents the abnormal rib; NR the normal rib; and N the normal spine. The

results of the quantitation ratio before and after therapy are as follows: rib (2.63 \rightarrow 1.41); Area I (2.29 \rightarrow 1.93); Area II (1.73 \rightarrow 1.56); and Area III (1.25 \rightarrow 1.24). The lesion-to-normal ratio shows a post-therapy reduction for Regions I, II, and the rib. However, Region III shows little alteration in ^{99m}Tc -diphosphonate uptake.

The use of ^{99m}Tc -diphosphonate to follow the changes in bone lesion uptake after therapy is outlined for a patient with multiple areas of metastases in the spine and the ribs from a primary adenocarcinoma of the lung. The ease of imaging the lesions with the gamma camera and the storing, retrieving, and quantization of the data represents a convenient way to study alterations in uptake relative to radiation therapy of bony metastases. This procedure will also be applied to follow the course of therapy in metabolic alterations of bone such as Paget's disease.

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