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The Gallium "Bone Scan" in Acute Leukemia

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A 15-year-old boy with acute leukemia had a gallium-67 scan that was virtually identical to his technetium-99m pyrophosphate bone scan, except for lack of renal visualization. The quality of the radiopharmaceutical was assured by the normal appearance of gallium scan performed in another patient on the same day and with the same radionuclide batch. This extensive osseous uptake was probably due to bone-marrow replacement by leukemia cells and is a pattern that should be recognized as indicating a diffuse marrow-infiltrating disease.

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A 15-year-old boy with an acute, poorly differentiated leukemia had a gallium-67 scan that had an appearance virtually identical to that of his technetium-99m pyrophosphate bone scan, except for the lack of renal uptake. The quality of the radiopharmaceutical preparation was assured, however, by the "typical" appearance of the gallium scan from another 15-year-old patient who, on the same day, was given Ga-67 from the same batch as the leukemia patient.

CASE REPORT

A 15-year-old boy with a 3-mo history of recurrent nose bleeds was admitted to Childrens Hospital of Los Angeles following a 5-hour episode of uncontrolled epistaxis. Physical examination revealed a slender, well-developed youth with no abnormalities except for his right-sided nose bleed. His blood count showed a pancytopenia (hemoglobin 4.7 g; total white-cell count 600/mm^3, with 56% lymphocytes, 18% segmented polymorphonuclear leukocytes, and 26% banded forms; platelets 22,000/mm^3). All liver function studies were normal, as was his prothrombin time and an SMA-12 survey. A bone-marrow biopsy showed massive replacement of normal cellular elements by an extensive, poorly differentiated leukemia.

A Tc-99m pyrophosphate bone scan (Fig. 1) was normal. The patient was injected with 3 mCi of Ga-67 citrate and a total-body scintigram was performed 72 hr later with a moving table and triple-peaked, standard field-of-view camera. The Ga-67 scan (Fig. 2A) showed only osseous uptake of radionuclide and resembled his bone scan (Fig. 1) except for the lack of renal radiogallium.

A 15-year-old girl (with a lymphoepithelioma) was also administered 3 mCi of Ga-67 from the same batch and on the same

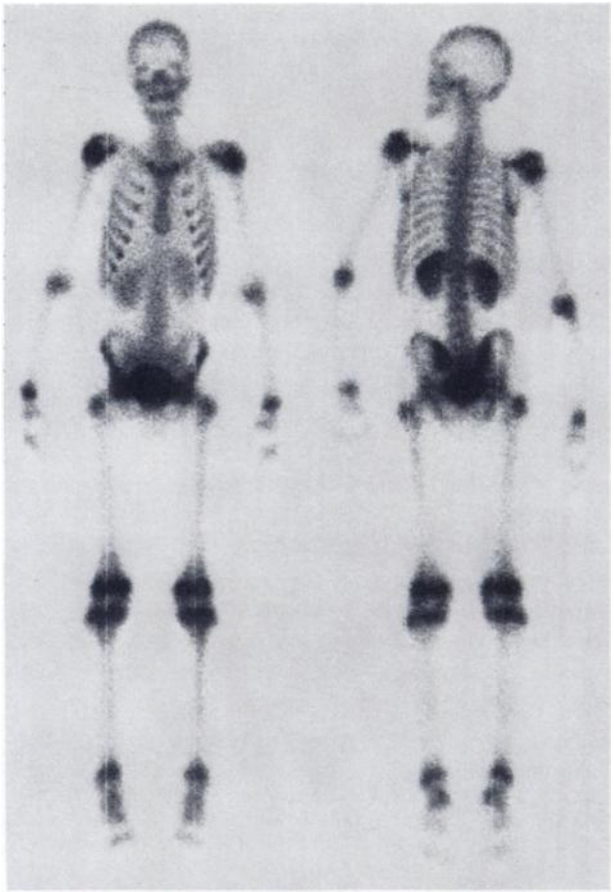

FIG. 1. Normal anterior and posterior Tc-99m pyrophosphate bone scintigrams of 15-year-old boy with leukemia.

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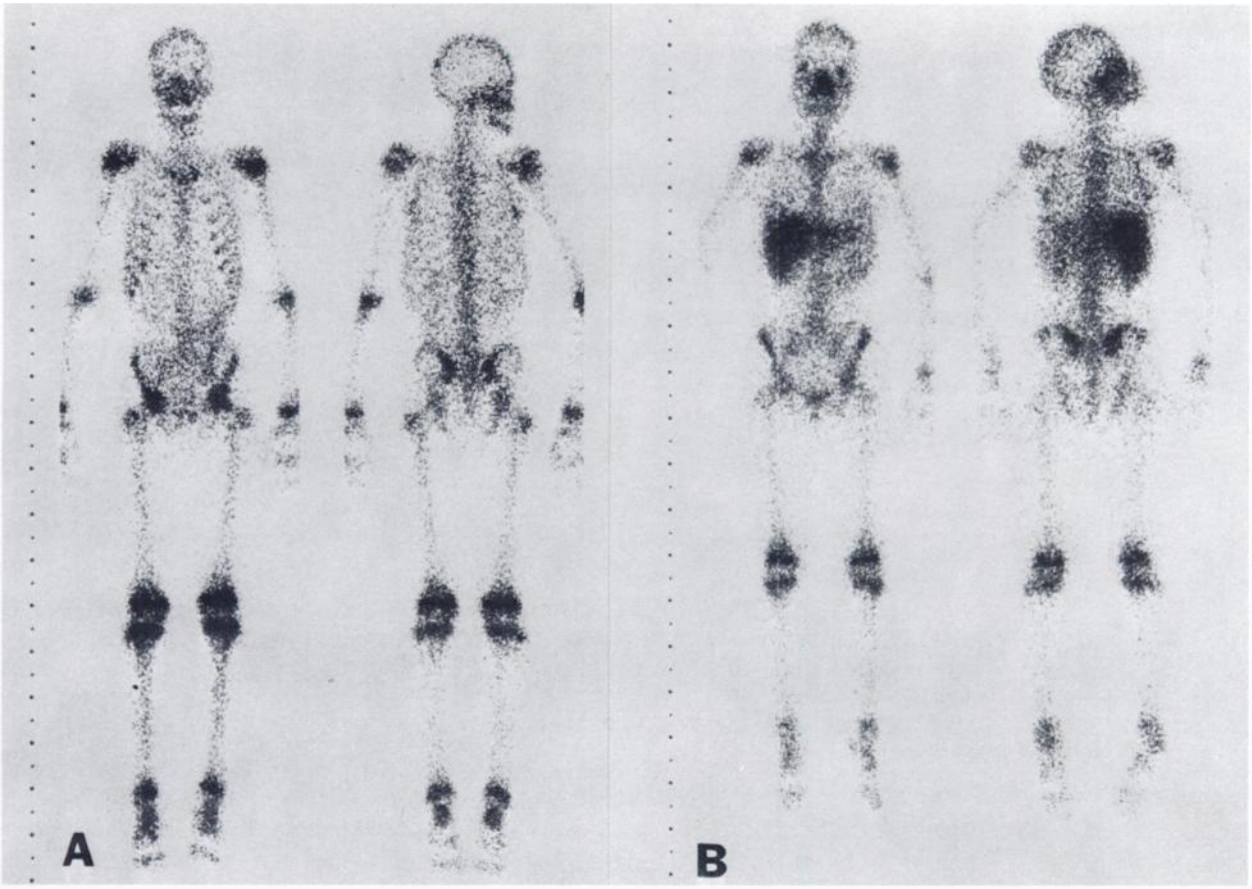

FIG. 2. (A) Gallium-67 study of patient shown in Fig. 1 (anterior and posterior views). Note excessive osseous localization of radionuclide, and lack of hepatic uptake. Gallium study resembles bone scintigram except for lack of renal localization. (Ga-67 shadow in lower left abdomen is colonic.) (B) Gallium-67 study of 15-year-old girl injected with gallium citrate from same batch as patient shown in Fig. 2A. Her scintigram shows typical normal distribution of Ga-67.

day as the leukemic boy. Her 72-hr total-body scintigram, performed with the same equipment as for the boy, showed a "typical" Ga-67 distribution (Fig. 2B). She had hepatic and lacrimal visualization and less osseous uptake.

The leukemic boy was treated with multiple chemotherapeutic agents and had a partial remission. He was discharged to be followed as an outpatient.

DISCUSSION

"Typical" Ga-67 scans at 48–72 hr show highest radionuclide concentrations in nasopharynx, liver, bone, and—to a lesser degree—spleen; localization may also occur in lacrimal and salivary glands, lactating breasts, and external genitalia (*1*). A significant redistribution of gallium, resulting in diffusely increased bone uptake, could occur in several situations: a) Ga-67 preparations containing stable gallium (*2*); b) diffuse liver disease with secondarily diminished hepatocytic activity resulting in compensatory uptake in bone (1); or c) leukemia (*3,4*). The quality of the Ga-67 batch used was assured by the control in another patient. The leukemic boy in this report had no clinical or laboratory evidence of liver disease. His bone marrow, however, was packed with poorly differentiated leukemic cells.

Milder et al. (*4*) have reported increased Ga-67 uptake throughout the long bones in 21 leukemic patients. This increased bone uptake occurred in children and adults with acute leukemia, either myelocytic or lymphocytic. The abnormal bone uptake correlated with the bone-marrow status: 76% of patients who had more than 75% blasts in the marrow had increased bone uptake. This diffuse uptake pattern suggested that Ga-67 binding was occurring in the leukemic marrow infiltration itself. This is supported by experimental evidence demonstrating Ga-67 uptake in tissues of leukemic AKR mice (*5*), in clinical myeloblastomas (*4*), and in the bone marrow and peripheral leukocytes of patients with chronic myelogenous leukemia (*4*). Milder (*4*), however, also reported increased liver uptake of Ga-67 in his patients and interpreted this as a manifestation of diffuse disease, although splenic uptake was variable. Following remission, liver and bone uptake decreased along with tracer accumulation in leukemic masses such as myeloblastomas. The pattern of increased radiogallium uptake in bone has also been observed in chronic myelogenous leukemia, but not in chronic lymphocytic (*4*).

The patient in this report differed from those reported by Milder in that there was no hepatic accumulation of Ga-67. The similarity of the gallium and bone scans was striking. Although there was extensive bone-marrow infiltration by leukemic cells (presumably resulting in avid gallium uptake to the exclusion of the normal sites), the bone scan was normal. The accentuated gallium uptake at the ends of the long bones is not surprising. These regions show increased activity on bone-marrow scans in children with an expanded normal marrow (*6*). Leukemia often presents radiographically as transverse radiolucent bands at the metaphyseal ends of the long bones, due to extensive leukemic

cellular proliferation in these regions (*7,8*). The functional basis of radiopharmaceutical distribution and gamma imaging is well demonstrated by this case. Recognition of this pattern of gallium distribution should suggest the presence of an infiltrative marrow process and not merely hepatic dysfunction.

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