Gallium Bone Scan in Myelofibrosis: Case Report

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When gallium is injected into a patient who has received many transfusions, the resultant scan appears similar to a bone scan with renal excretion. This case report presents a 51-year-old man with myelofibrosis and myeloid metaplasia. Gallium-67 and ^{52}Fe scans with ^{99m}Tc-pyrophosphate bone scintigrams are included.

J Nucl Med 18: 445–447, 1977

The use of gallium and indium as bone-scanning agents has been noted as early as 1965 with the report of Hayes et al. on ^{68}Ga (*1*), and a later report in 1968 by Mishkin and Reese on ^{113}In (*2*). When transferrin (a beta globulin) was saturated with prior injections of iron, indium, or gallium, a typical bone scan with renal localization was obtained. More recently, gallium has been found to exist in free form, or partly in association with transferrin, while indium, scandium, and gallium compete in decreasing order with iron transferrin binding in plasma (*3*). Ito noted that gallium appeared to bind with the smaller protein fractions, perhaps even albumin (*4*). In 1975 Hill et al. (*5*) described experiments on iron-induced enhancement of gallium uptake in a human leucocyte culture medium, and in 1976 Oster (*6*) studied enhancement of gallium imaging with iron dextran in rabbit abscesses. The following case report gives an example of altered gallium localization in a patient with myelofibrosis and myeloid metaplasia who was maintained with frequent transfusions.

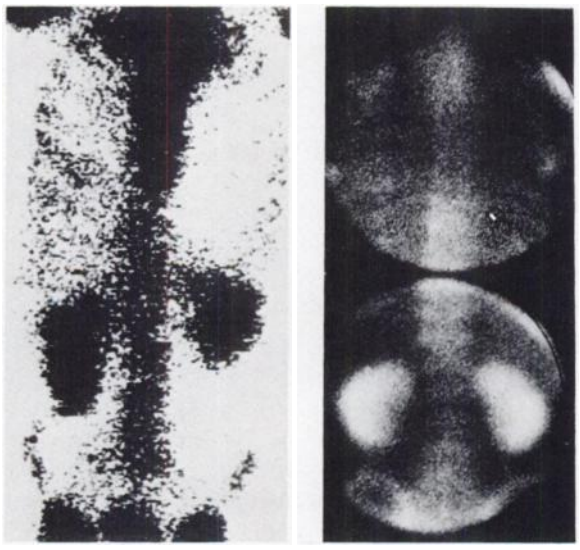

FIG. 1. Gallium-67 scan simulating pyrophosphate bone scan. Left, gallium scan, right, bone scan.

CASE REPORT

A 51-year-old man had a 6-year history of myelofibrosis with metaplasia and extramedullary hematopoiesis. In 1972 a splenectomy was performed for hypersplenism. By 1975 the patient was suffering from anemia, chronic thrombocytopenia, and intermittent leukopenia, resulting in multiple admissions for localized abscesses, septicemia, and urinary-tract infections. He developed a transfusion requirement of 4–5 units of packed cells every 4–7 weeks and received a total of 185 units of packed cells with resultant hemosiderosis. In May 1975 the patient was admitted to the hospital for studies which included the following laboratory tests: urine analysis: normal; hematocrit: 23.3%; hemoglobin: 7.6 g%; WBC: 4,000/mm^3. Per high-power field there were 11 myeloblasts, 2 myelocytes, 2 segmented neutrophils, 42 lymphocytes, 2 eosinophils, 32 basophils, 8 monocytes, 1 metamyelocyte and 24 nucleated red cells. Platelets: 65,000/mm^3; serum iron-binding

Received July 26, 1976; revision accepted Jan. 5, 1977.

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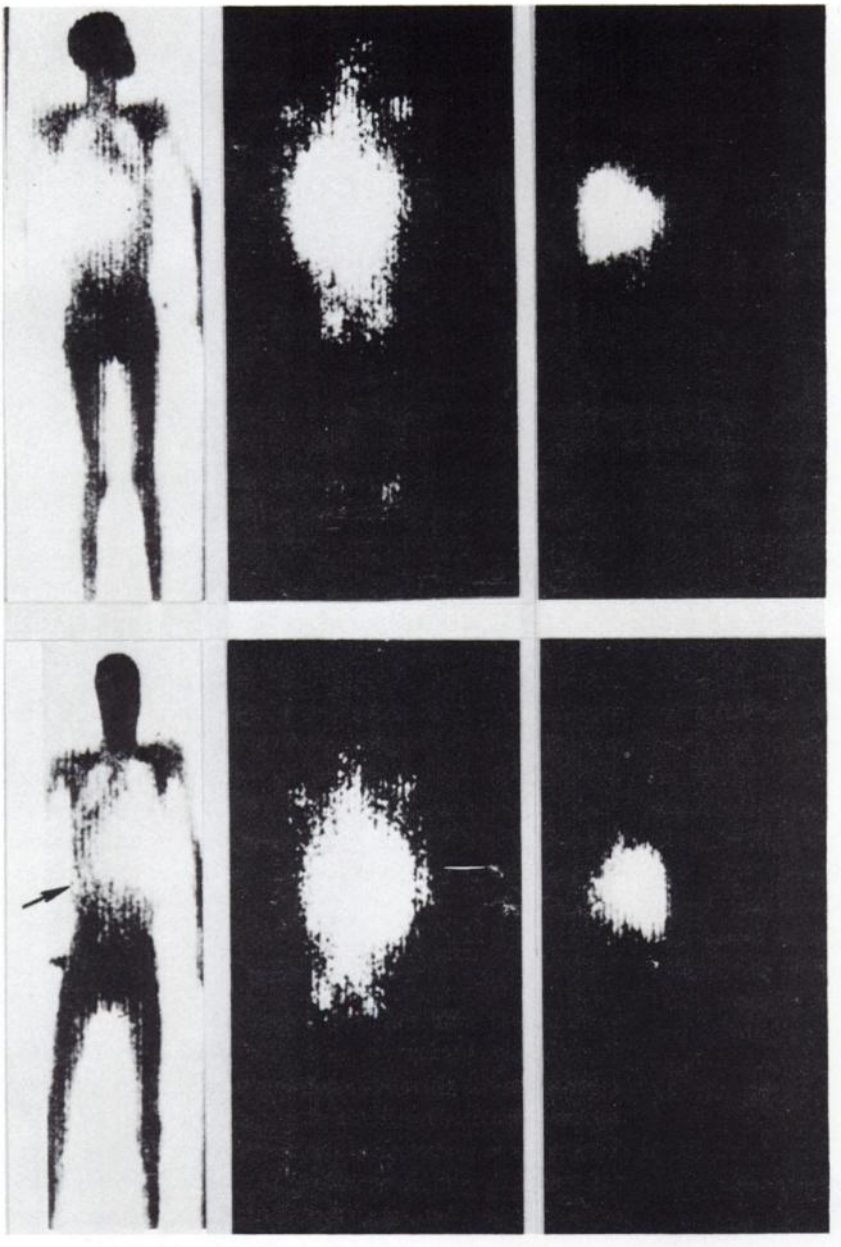

FIG. 2. Iron-52 total-body bone scans of patient in Fig. 1. Anterior in upper figure, and posterior in lower. Left portion is transmission/emission scan, while black portion on right shows low-intensity emission scan on far right and high-intensity emission scan in middle. Arrow points to left renal labeling.

capacity: 210 μg% (normal 250–400); and total serum iron: 195 μg% (normal 65–150).

Liver/spleen scintigraphy was performed using 6 mCi of ^{99m}Tc-sulfur colloid, followed by a bone-marrow scan. This combined study revealed an enlarged liver with irregular uptake, no visualization of the spleen, and no radionuclide concentration in the marrow of the peripheral or axial skeleton. Seventy-two hours after injection of 3 mCi of carrier-free ^{67}Ga-citrate, a scan was done of the trunk from the thyroid cartilage to the symphysis pubis. This scan appeared almost identical with the ^{99m}Tc pyrophosphate bone study, which was done 2 days after the gallium scan and showed labeling in the liver and increased labeling in both kidneys, the bladder, and the axial skeleton (Fig. 1). Finally, a ^{52}Fe total-body scan,* done 1 day after intravenous injection of 100 μCi of this nuclide, depicted a markedly increased uptake in the liver, with decreased uptake in the central bone marrow, some peripheral extension around the knee and elbow joints, and slight uptake in the left kidney (Fig. 2). The right kidney area was obscured by the liver activity.

Other studies relevant to the patient's diagnosis include a percutaneous liver biopsy, which showed hemosiderosis and extramedullary hematopoiesis. Histologic examination of the spleen demonstrated extramedullary hematopoiesis, fibrosis, and nucleated red blood cells. Three bone-marrow biopsies

showed fibrotic bone marrow with no myeloid or erythroid cells. Numerous previous chest roentgenographs and a radiographic bone survey showed diffuse bony sclerosis.

DISCUSSION

From the early studies of Brucer et al. in 1953, it has been known that some of the injected gallium goes to bone marrow and new-bone formation (*7*). Hara (*3*) confirmed that carrier-free ^{67}Ga localizes in marrow and the metaphyseal area of bones, with a shift to the metaphysis when carrier gallium is injected simultaneously. In this patient, with plasma iron saturation and a resultant greater affinity of the tracer for osteoblastic tissue than for bone marrow, ^{67}Ga distributes in the myelosclerotic areas of bone.

The appearance of gallium in the patient's kidneys, in the context of normal renal function, is probably best explained by renal excretion of the tracer—as is seen in the ^{99m}Tc-pyrophosphate bone scans. Renal inflammatory processes and extramedullary hematopoiesis were considered, but inflammation could not be demonstrated (*8,9*). The ^{52}Fe scan showed slightly increased activity in the kidneys however, as compared with the liver activity. Thus, extramedullary hematopoiesis was minimal in the kidneys at the time of these studies.

Many mechanisms have been proposed to explain in vivo gallium binding. A reasonable analysis was summarized by Ito (*4*). He noted each step of this binding process, including the labeling of plasma, the vascular supply, the target area, the extravasation, and finally the binding to the tissue. Until more definitive studies are done, an area of carrier-free gallium labeling will continue to be thought of as a high-affinity, low-capacity compartment (*10*). Straw demonstrated that gallium administered with carrier did not result in selective uptake in lymphosarcomas in dogs, and that kidney cortex and bone marrow showed gallium labeling that greatly exceeded the tumor labeling (*10*).

Other agents have been implicated in cases of unusual distribution of gallium. Prior administration of many of the cytotoxic pharmaceuticals has been suspected in instances of the redistribution of gallium. Vincristine, given 2 hr before ^{67}Ga-citrate injection, has resulted in gallium bone scans similar to those shown in this report (personal communication). If, however, a gallium scan shows renal labeling and decreased hepatic labeling, with prominent bone labeling, saturated transferrin should be considered as one of the most common causes of gallium redistribution.

FOOTNOTE

* Study done on Anger Mark II Scanner with americium generating the transmission scan.

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