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SELF-STUDY TEST Skeletal Nuclear Medicine

Questions are taken from the *Nuclear Medicine Self-Study Program I*, published by The Society of Nuclear Medicine

DIRECTIONS

The following items consist of a heading followed by numbered options related to that heading. Select those options you think are true and those that you think are false. Answers may be found on page 1993.

You are shown images from a bone scan performed with ^{99m}Tc MDP (Fig. 1). Which of the following are reasonable explanations for the scintigraphic findings?

- Use of highly deoxygenated, preservative-free saline to dilute the radiopharmaceutical
- Excessive Al³⁺ breakthrough in the eluate from the technetium generator
- Excessive free reduced ^{99m}Tc in the radiopharmaceutical
- The presence of gentisic acid in the radiopharmaceutical
- Excessive free ^{99m}Tc pertechnetate in the radiopharmaceutical

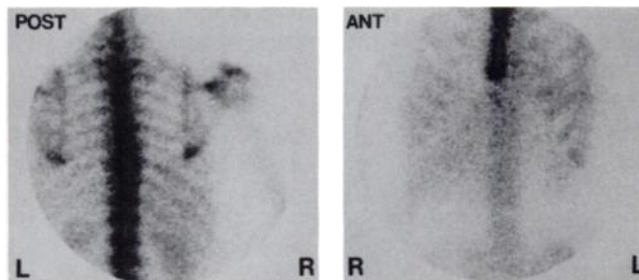


FIGURE 1.

This 62-year-old man has bronchogenic carcinoma. You are shown selected images from a bone scan with ^{99m}Tc MDP (Fig. 2). Reasonable explanations for the findings in the urinary tract include which of the following?

- Recent chemotherapy
- Hypercalcemia
- Obstructive uropathy
- Renal metastases
- Iron overload

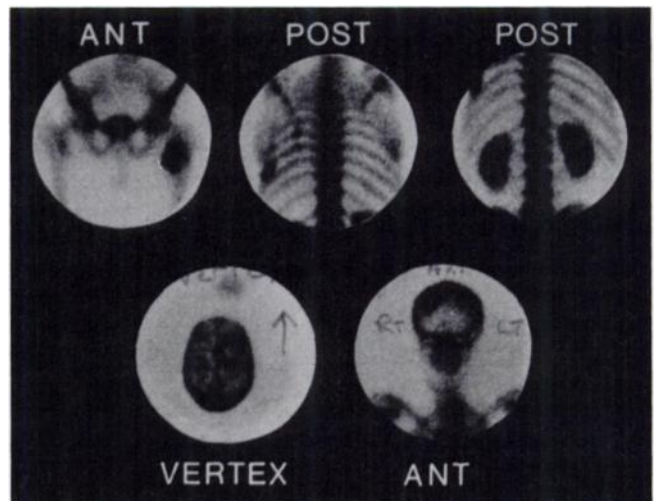


FIGURE 2.

This child has left hip pain. Plain radiographs were normal. You are shown pinhole images of the hips obtained with ^{99m}Tc MDP (Fig. 3). Diagnoses that should be considered, based on the scintigraphic findings, include which of the following?
(continued on page 1993)

13. Yaoita H, Juweid M, Wilkinson R, et al. Detection of myocardial reperfusion injury with Tc-99m glucarate [Abstract]. *J Nucl Med* 1990;31:795.
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(continued from page 1934)

SELF-STUDY TEST

11. Legg-Perthes disease
12. Septic arthritis
13. Hemarthrosis
14. Gaucher's disease
15. Transient synovitis of the hip
16. Chondroblastoma

Figure 4 shows ^{99m}Tc MDP images obtained 3 and 24 hours postinjection. The abnormality noted could be caused by

17. radiation therapy.
18. focal calyceal obstruction.
19. renal cell carcinoma.
20. sickle cell anemia.
21. metastatic osteogenic sarcoma.

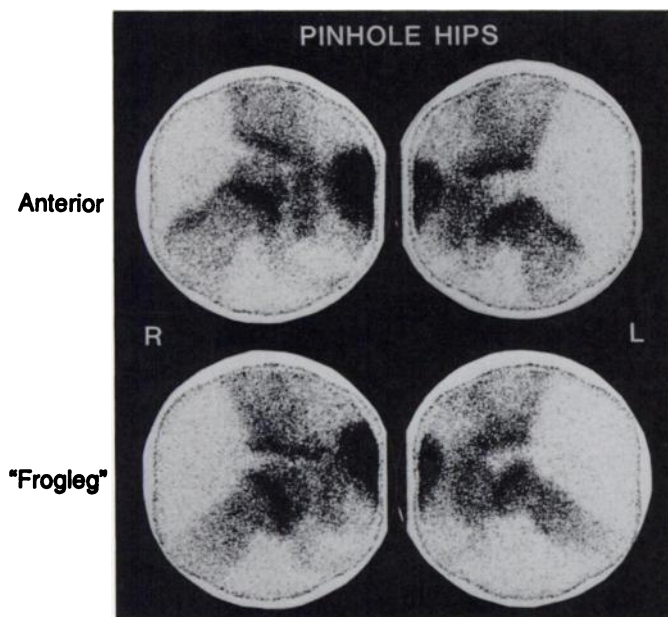


FIGURE 3.

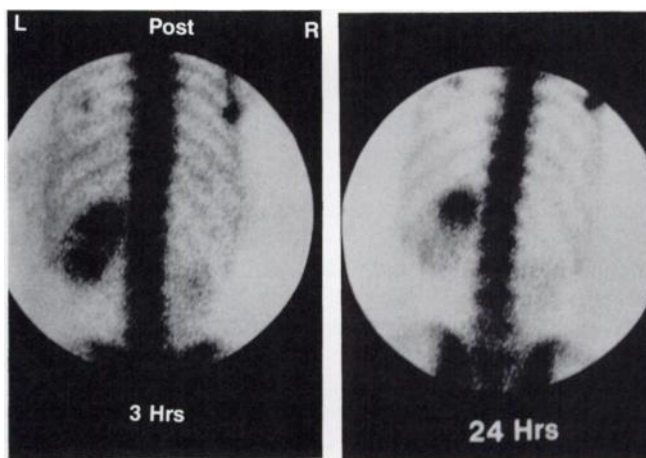


FIGURE 4

SELF-STUDY TEST **Skeletal Nuclear Medicine**

ANSWERS

ITEMS 1-5: Hepatic Activity on Bone Scintigraphy

ANSWERS: 1, F; 2, T; 3, T; 4, F; 5, F

The images in Figure 1 demonstrate increased hepatic uptake of the radiopharmaceutical. Hepatic uptake on bone scintigraphy occasionally results from the formation of a colloid of technetium oxides (e.g., TcO₂), which may occur when the pH of the reaction mixture is alkaline rather than acidic, and when excessive stannous ion is present. On radiochromatography, this colloidal contaminant will be measured as "free reduced technetium," which remains at the origin on paper or thin-layer chromatograms in either saline or acetone. Aluminum ion

breakthrough in the eluate of a technetium generator may result in colloid formation through production of an aluminum-technetium complex. This effect begins to appear at Al³⁺ concentrations in the eluate exceeding 10 μg/ml. This aluminum effect also has been observed in patients taking aluminum-containing antacids, and presumably reflects colloid formation in vivo. The reticuloendothelial system of the liver is quite efficient in phagocytizing ^{99m}Tc colloids, whatever the origin.

The inadvertent introduction of oxygen or other oxidizing agents into the reagent vial will lead to reoxidation (or insufficient reduction) of

(continued on page 2035)

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SELF-STUDY TEST

Skeletal Nuclear Medicine

ANSWERS

diagnosed in the second and third decades of life. Chondroblastoma might be considered in this patient because this tumor typically involves an epiphysis or apophysis of a long tubular bone. However, by the time a chondroblastoma is symptomatic, the plain radiographs should show a radiolucent lesion. Additionally, these lesions generally show intensely increased activity on bone scintigraphy and would not be expected to give a photon-deficient lesion without marked destruction evident on the radiograph.

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ITEMS 17-21: Focal Renal Uptake of ^{99m}Tc MDP

ANSWERS: 17, T; 18, T; 19, F; 20, F; 21, T

Figure 4 demonstrates asymmetric renal activity at 3 hours and local retention of ^{99m}Tc MDP in the upper pole of the left kidney at 24 hours. Asymmetric renal activity is a common finding on bone scintigraphy and is most often due to slower clearance of the tracer from the more capacious collecting system of the kidney with greater activity. It is of potential clinical importance because it may be confused with or mask an osseous lesion in the 12th rib. Usually, by repeat imaging with the patient erect, this activity will disappear secondary to gravitational drainage or will change in position (as the kidney descends) such that its true nature will be apparent. Occasionally, repeat imaging at 24 hours or after ad-

ministration of furosemide is necessary to resolve the problem. Even then, however, if there is focal calyceal obstruction by stone, tumor, or an inflammatory process, activity might persist in the affected calyces to 24 hours.

Most renal masses, including nearly all renal cell carcinomas, will appear on bone scintigraphy as focal areas of decreased activity by comparison with the normal renal parenchymal activity. One unusual exception is osteosarcoma metastatic to the kidney, in which there is accumulation of ^{99m}Tc MDP in the bone produced by the tumor. This is the actual cause of the abnormality seen in this patient.

Radiation therapy also has been reported to cause focal retention of ^{99m}Tc MDP within the irradiated volume of the kidney. This may reflect the reduced blood flow and prolonged tracer transit time in the irradiated renal tissue or accumulation in injured tissue.

In patients with sickle cell anemia, bone scintigraphy typically shows diffusely increased renal parenchymal activity in enlarged kidneys; locally increased activity is not seen. The increased activity in the upper pole of the left kidney of this patient should not be confused with the splenic uptake often seen in patients with sickle cell disease.

[Test Figure 4 reprinted with permission from Gilbert LA, Weiss MA, Hawkins HH, Nishiyama H, Aron BS. Detection of renal metastasis of osteosarcoma by bone scan. *Clin Nucl Med* 1983;8:325.]

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For further in-depth information, refer to the syllabus pages in Nuclear Medicine Self-Study I.

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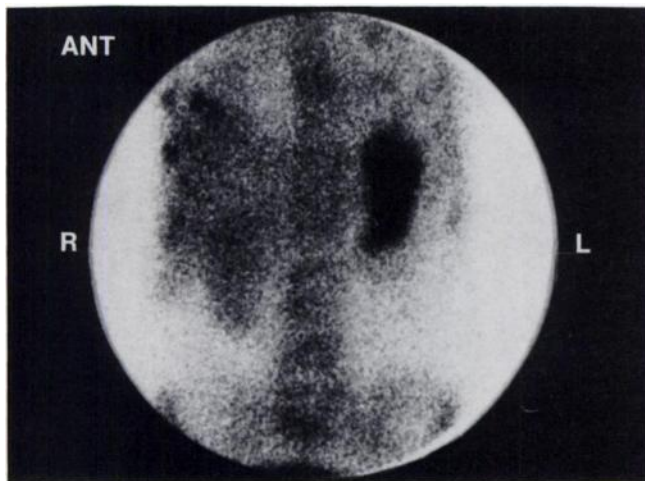
SELF-STUDY TEST

Skeletal Nuclear Medicine

ANSWERS

technetium, some of which will then be in the +7 valence state as ^{99m}Tc pertechnetate. Hence, the saline used to reconstitute preparations of ^{99m}Tc MDP should be highly deoxygenated and preservative free.

Gentisic acid is an anti-oxidant, as is ascorbic acid. Both agents protect the stannous ion and technetium from oxidation by oxygen or radiolytic products. The pattern shown in Figure 1 is not typical of excessive free ^{99m}Tc pertechnetate, in which excessive gastric activity would be expected (Fig. II).



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ITEMS 6-10: Diffuse Renal Parenchymal Localization of ^{99m}Tc MDP

ANSWERS: 6, T; 7, T; 8, F; 9, F; 10, T

The scintigrams shown in Figure 2 demonstrate diffusely increased activity in thoracic and lumbar vertebrae and in both iliac bones. There also are focal lesions in the left lesser trochanter, several ribs, and the calvarium. (The large right parietal "doughnut" lesion actually was due to a prior craniotomy for resection of a solitary cerebral metastasis.) These osseous abnormalities most likely reflect widespread metastatic disease.

In addition, there is intensely increased activity in the parenchyma of both kidneys. In this clinical setting, the most likely explanation for this finding is hypercalcemia associated with multiple skeletal metastases.

Less often, in a patient with cancer of the lung, the hypercalcemia would be due to a humoral mechanism. Recent anticancer chemotherapy with a variety of drugs, including cyclophosphamide, vincristine, and doxorubicin, also has been observed to cause similar scintigraphic findings. Additionally, intense renal parenchymal localization of ^{99m}Tc diphosphonates may be seen in patients with iron overload due to multiple transfusions or hemochromatosis.

With early obstructive uropathy, the retained renal activity may appear to be predominantly parenchymal in location. Much more often with obstruction, the tracer can be seen to be clearly within the dilated collecting system and ureter. In this patient, the absence of columning of activity in the ureters, the "normal" size of the bladder (arguing against bladder outlet obstruction), and the parenchymal rather than pelvicalyceal distribution of the renal activity all make bilateral obstructive uropathy an unlikely explanation for the scintigraphic findings.

Although cancer of the lung commonly metastasizes to the kidneys (twice as common at autopsy as renal cell carcinoma), renal metastases would not cause diffusely increased parenchymal uptake of ^{99m}Tc MDP. Rather, focal deposits would appear as localized areas of decreased activity and diffuse infiltration might lead to a generalized decrease in activity in an enlarged kidney.

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ITEMS 11-16: Photon-Deficient Femoral Capital Epiphysis

ANSWERS: 11, T; 12, T; 13, T; 14, T; 15, T; 16, F

The pinhole images in Figure 3 show absence of tracer uptake in the left femoral capital epiphysis, indicating a compromised blood supply. The childhood disorder most commonly associated with this scintigraphic finding is Legg-Perthes disease, an idiopathic form of avascular necrosis. Any infiltrative disease, such as Gaucher's disease and osteomyelitis, may compromise the blood supply to the femoral capital epiphysis as the infiltrative process (engorged macrophages, pus, tumor) expands within the bone marrow cavity. When this occurs, the bone-seeking radiopharmaceutical is not delivered to the site of disease, and a photopenic area will result.

The fluid within the capsule of the hip in association with hemarthrosis, septic arthritis, and transient synovitis may raise the pressure within the joint to such an extent that it impairs blood flow to the femoral capital epiphysis, causing a "cold" region scintigraphically. If the fluid is removed promptly, the activity generally will return on a subsequent study, but if the increased pressure is sustained for a prolonged time, osteonecrosis may result. This is most likely to occur with septic arthritis, in which drainage of the hip joint should be performed as a surgical emergency.

Chondroblastoma is an uncommon primary bone tumor most often

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13. Yaoita H, Juweid M, Wilkinson R, et al. Detection of myocardial reperfusion injury with Tc-99m glucarate [Abstract]. *J Nucl Med* 1990;31:795.
14. Orlandi C, Crane PD, Edwards S, et al. Early scintigraphic detection of experimental myocardial infarction in dogs with technetium-99m-glucuric acid. *J Nucl Med* 1991;32:263-268.
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SELF-STUDY TEST

11. Legg-Perthes disease
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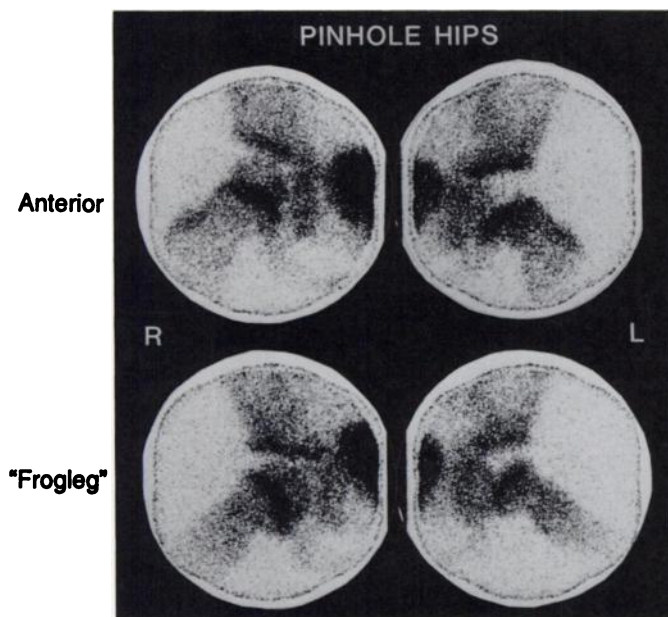


FIGURE 3.

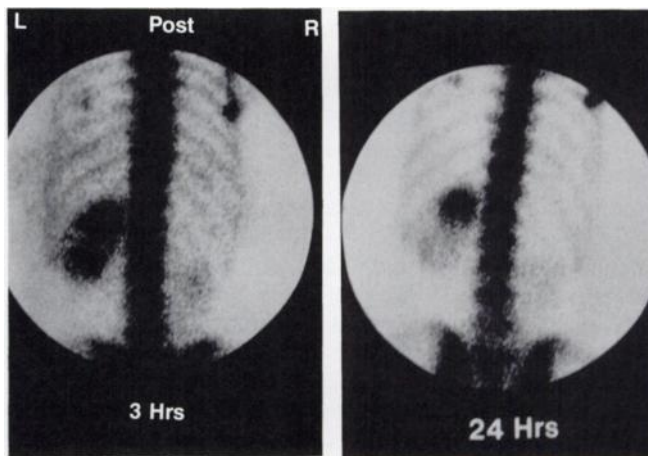


FIGURE 4

SELF-STUDY TEST **Skeletal Nuclear Medicine**

ANSWERS

ITEMS 1-5: Hepatic Activity on Bone Scintigraphy

ANSWERS: 1, F; 2, T; 3, T; 4, F; 5, F

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