

**AUGMENTED RADIOACTIVITY ON BONE SCANS OF LIMBS BEARING OSTEOSARCOMAS**

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***Thirteen patients with biopsy-proven osteosarcomas were studied with <sup>99m</sup>Tc-labeled bone-scanning agents. In addition to the dense areas of abnormal uptake corresponding to the tumors, ten patients exhibited a relative increase of radioactivity at the ends of the long bones of the affected extremities. Several of these areas were included in the surgical specimens but no tumor cells were found.***

The clinical management of patients with primary osteosarcomas frequently depends on the presence or absence of detectable hematogenous metastases at the time of diagnosis. Bone-seeking radioisotopes not only concentrate selectively in the secondary osseous lesions but also in some of the pulmonary metastases (1,2). Thus it is possible to assess the two most common sites of blood-borne metastases of osteosarcoma: the lungs and bones (3,4).

**MATERIALS AND METHODS**

During a period of 13 months, all patients who were referred to the New York University Medical Center with a preoperative diagnosis of osteosarcoma were studied by radioisotopic bone scans as well as routine roentgenographic techniques. Thirteen patients, aged 10–31 years, had biopsy-proven osteosarcomas. All of the tumors were in the lower extremities, adjacent to the knees: nine in the distal femur, three in the proximal tibia, and one in the proximal fibula. One of the subjects had a primary parosteal lesion that had invaded the adjacent femur.

The scan examination included both lower extremities, the pelvis, and the chest. Scans were performed with a maximum dose of 10 mCi of <sup>99m</sup>Tc-polyphosphate or 15 mCi of <sup>99m</sup>Tc-diphosphonate with the individual dose adjusted to the patient's weight. The studies were done on a Searle Pho/Gamma HP scintillation camera using a high-resolution, low-energy, parallel-hole collimator. A single

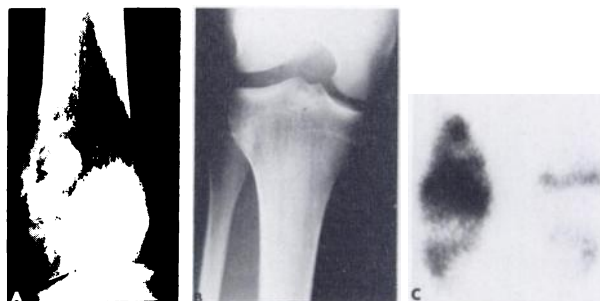
study was performed on a Raytheon rectilinear scanner with a 5-in. crystal.

**RESULTS**

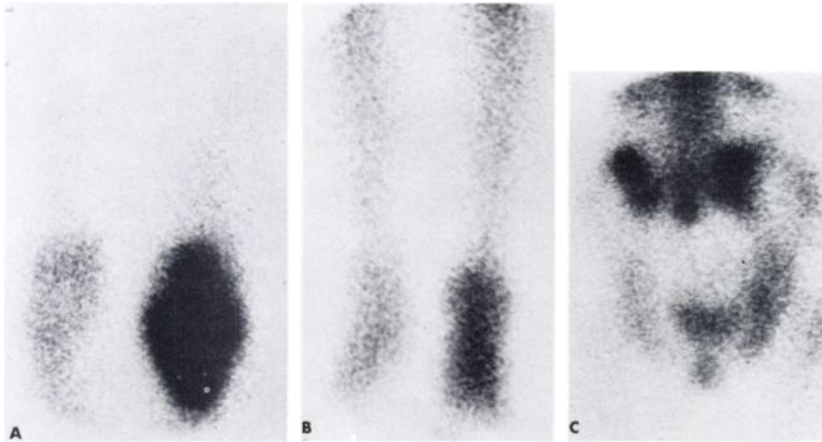
On reviewing the 13 cases of primary osteosarcoma, the radioisotopic bone scans demonstrated dense areas of abnormal uptake corresponding to the tumors as shown by x-ray films and pathologic studies. In addition, the bone scans of 10 of these 13 patients showed a definite asymmetry of activity between the epiphyseal regions in the tumor-bearing limb when compared with the opposite extremity (Fig. 1). These areas of relative increased activity occurred most often on the side of the knee joint opposite the primary tumor. However, some individuals demonstrated this phenomenon throughout the affected limb (Fig. 2). The x-ray films of these areas revealed no abnormalities. Five of the ten patients had one or more of these areas included in the surgical specimens. In no case were tumor cells identified.

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**FIG. 1.** (A) X-ray film of 15-year-old boy with primary osteosarcoma in right distal femur. (B) X-ray film of adjacent tibia is unremarkable. (C) Scan of both knee areas shows that in addition to dense area of abnormal isotopic uptake corresponding to tumor, there is definite augmentation of activity at proximal end of tibia when compared with other side.



**FIG. 2.** Studies of a 16-year-old girl with primary osteosarcoma in left proximal tibia. (A) Scan of both knees showing tumor as well as augmented activity in distal end of left femur. (B) Scan of lower legs demonstrates increased activity in area of left ankle as compared with right. (C) Scan of pelvic area showing augmented activity in left hip region.

The x-ray films of the patients who did not exhibit this scan finding revealed densely sclerotic lesions. However, three patients with asymmetry of isotopic uptake also had predominantly sclerotic primary tumors. Two of the patients with symmetrical uptake had definite radiographic evidence of disuse osteoporosis in the tumor-bearing limb while only one case with augmented areas of uptake showed the latter x-ray changes.

#### DISCUSSION

Until recently, bone-seeking radioisotopes have not been extensively used for the diagnosis and management of primary bone tumors in children and young adults due to high radiation doses (1). With the advent of short-lived,  $^{99m}\text{Tc}$ -labeled radiopharmaceuticals, this objection has been negated.

The relative increase in the isotopic uptake observed in the epiphyses of extremities affected by osteosarcoma presumably did not result from secondary sites of tumor. The phenomenon of augmented radioactivity was most frequently observed in the bones abutting the knee, the location of all the primary tumors. However, similar findings were seen in ankles and hips, suggesting that this was not a primarily joint-related occurrence. The asymmetrical distribution of the radionuclide may be related to the increased vascularity produced by the tumor (3). The rich vascular anastomosis around the knee joint would explain the predominance of the finding in bones adjacent to the joint space. The three patients not exhibiting this finding all had densely sclerotic and relatively avascular lesions. However, three of the patients with this finding also had predominantly sclerotic lesions.

A related etiology may be early disuse osteoporosis. Transient osteoporosis, as seen in the syndrome of "regional migrating osteoporosis," can produce areas of increased activity on isotopic bone scans (5,6) due to a postulated increased rate of

remodeling (5). Experimental evidence also indicates that early disuse osteoporosis is associated with a transient increase in vascularity that can be measured with  $^{85}\text{Sr}$  extraction studies (7). The scan findings in osteoporosis frequently precede the roentgen changes and may resolve when established osteoporosis becomes evident on the roentgenograms. It is interesting to note that two of the three patients not exhibiting asymmetry of the isotopic activity in the lower extremities had clear radiographic evidence of osteoporosis in the tumor-bearing limb. Only one of the ten patients who did exhibit asymmetry showed radiologic changes of osteoporosis.

The recognition of this phenomenon may be of significance in that increased activity may be mistaken for hematogenous metastases to bone. It is proposed that the basis of this observation is the associated disuse osteoporosis during an early active phase or the hyperemia that accompanies vascular, malignant, bone-forming tumors or both.

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