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The Usefulness of Bone and Bone-marrow Scintigraphy in the Detection of Bone Involvement in Patients with Multiple Myeloma

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ABSTRACT. We used a combination of bone and bone-marrow scintigraphy to evaluate bone involvement in 15 patients with multiple myeloma (7 in untreated group and 8 in chemotherapy group).

Of the 3 cases in untreated group whose ^{99m}Tc-methylene diphosphonate (MDP) bone scans showed no abnormality, one had abnormal ^{99m}Tc-suffer colloid bone-marrow scintigraphy. In other 4 cases of untreated group whose bone scan showed cold defects, bone-marrow scintigraphy delineated clearly the areas of tumor-cell invasion.

On the other hand, in all chemotherapy cases, multiple hot spots were observed on bone scintigram, but on bone-marrow scintigram abnormalities were not recognized.

In conclusion, the combination scintigraphy of bone and bone-marrow was a useful method in evaluating bone involvement in patients with multiple myeloma.

Key words : Multiple myeloma — Bone-marrow scintigraphy — Bone scintigraphy

Bone scintigraphy with ^{99m}Tc-phosphorous compound is often employed to detect bone lesions of multiple myeloma.[1] ^{99m}Tc-phosphorous compounds are reported to accumulate in areas of vigorous bone renewal or an increased bone formation,[2] and to accumulate strongly in areas of bone metastasis in which bone formation occurs along with osteolysis. However, slight accumulation of the radionuclide on bone scintigraphy is experienced in cases of multiple myeloma, in which mostly osteolysis with little bone formation take place, despite the existence of a neoplasm in the bone-marrow and of osteolytic foci.[3] Bone marrow scintigraphy on the other hand, is useful in demonstrating metastasis to the bone-marrow, besides being valuable in evaluating hemopoiesis in hematological disorders.[4,5] For this reason, bone-marrow scintigraphy, in combination with roentgenography and bone scintigraphy, promises to provide an accurate diagnosis of osseous lesions of multiple myeloma. In this study, we evaluated the usefulness of bone and bone-marrow scintigraphy in detecting osseous lesions and in accessing the effectiveness of treatment in multiple myeloma.

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TABLE 1. Bone and bone marrow scintigraphies and roentgenographic findings.

Case		Age (Sex)	Bone scintigraphy	Bone marrow scintigraphy (skull, humerus, femur, lumbar, pelvis)	Bone X-P
untreated group					
1	T.O.	63 (M)	n.p.	n.p.	lumbar spines : spondylosis deformans
2	K.M.	64 (M)	n.p.	n.p.	punched out lesion (−)
3	T.I.	71 (M)	n.p.	skull	skull : punched out
4	Y.F.	58 (F)	rt humerus*	skull, rt humerus	skull : punched out, rt humerus : large destructive lesion
5	M.S.	66 (M)	skull,* ribs	skull, lumbar, pelvis, femur	skull, pelvis, femur : multiple punched out lesions
6	Y.H.	49 (M)	rt femur,* sternum*	rt femur	sternum : punched out, femur : osteolytic
7	K.F.	56 (F)	skull,* rt ilium,* ribs	skull, rt ilium	skull : punched out, ribs : fracture, pelvis : porotic
chemotherapy group					
8	T.S.	39 (F)	L_5	n.p.	L_5 : compression fracture
9	I.Y.	57 (F)	skull, ribs, pelvis	skull	skull, pelvis femur : multiple punched out lesions, ribs : lytic
10	M.S.	45 (F)	skull, ribs, $L_{2,5}$	skull	skull : punched out, L_2 : sclerotic, L_5 : lytic
11	T.O.	57 (M)	skull, ribs, L_5	skull, L_5	skull : punched out, ribs : lytic, L_5 : compression fracture
12	M.M.	68 (M)	L_2, L_4	L_4	L_2, L_4 : compression fracture
13	H.H.	40 (F)	ribs, L_2, L_4	L_4	L_2, L_3, L_4 : compression fracture, osteoporotic, ribs : lytic
14	Y.N.	52 (M)	Th_{12}, L_5	L_5	Th_{12}, L_5 : compression fracture
15	M.M.	47 (F)	pelvis (ilium)	pelvis (ilium)	pelvis : punched out, lumbar spines : osteoporotic

* Cold lesion

MATERIALS AND METHODS

Included in the study were 15 patients (7 untreated and 8 treated chemotherapeutically) with multiple myeloma who were admitted at Kawasaki Medical School Hospital during the 6-year period from 1979 to 1985. The diagnosis were confirmed histologically and immunologically. For bone-marrow scintigraphy, 5 mCi of ^{99m}Tc-sulfur colloid (TCK-1 ; Midorijuji) was injected intravenously, and 30 min later images were taken of the bone-marrow of the skull, humerus, lumbar vertebrae, pelvis and femur. For bone scintigraphy, 20 mCi of ^{99m}Tc-MDP (Midorijuji) was injected intravenously, and 3 hours later whole-body images and spot images of the suspected lesions were taken. The findings from both types of scintigraphy were compared between the untreated and treated patients as to the presence and degree of accumulation of the radionuclides. Both types of scintigraphy and roentgenographic examination were performed within few days and before bone-marrow biopsy.

RESULTS

The finding of the bone and bone-marrow scintigraphic and skeletal roentgenographic examinations are presented in Table 1.

In 3 of the 7 untreated patients, no abnormalities were shown by bone scintigraphy. In 2 of these 3 patients, no abnormalities were also revealed by either roentgenography or bone-marrow scintigraphy. In the one remaining patient, multiple cold lesions in the skull were observed by bone-marrow scintigraphy, and small punched-out lesions were seen on skull roentgenograms.

In other 4 untreated patients lesions were demonstrated in the humerus, in the skull and ribs, in the femur and sternum, and in the skull and ilium respectively, by bone scintigraphy. Although application of bone-marrow scintigraphy was limited to the skull, humerus, lumbar vertebrae, pelvis and femur, more lesions could be revealed and the extent of each lesion was more clearly defined by this method than by bone scintigraphy.

In all 8 treated patients, are as of increased radioactivity were observed on bone scintigraphy. However, once fractures occurred as a result of invasion of myeloma, hot lesions bone scintigraphy was not changed regardless of the effectiveness of the treatment.

Cold lesions in the skull, lumbar vertebrae and pelvis were also observed by bone-marrow scintigraphy. Comparing with findings on bone scintigraphy, few lesions that were showed the increased radionuclide accumulation on bone scintigram were found to be not cold but normal on bone-marrow scintigraphy.

Case 1

A 56-year-old woman was admitted because of appetite loss and pain of the right leg. Bone scintigraphy showed a photon deficient area in the right ilium (Fig. 1a). Bone-marrow scintigraphy revealed a cold defect in the right ilium (Fig. 1b). Bone roentgenogram of the pelvis showed only osteoporotic change (Fig. 1c).

Case 2

A 66-year-old man was admitted because of severe back pain. Bone roentgenograms showed multiple punched-out lesions in the skull, pelvis and

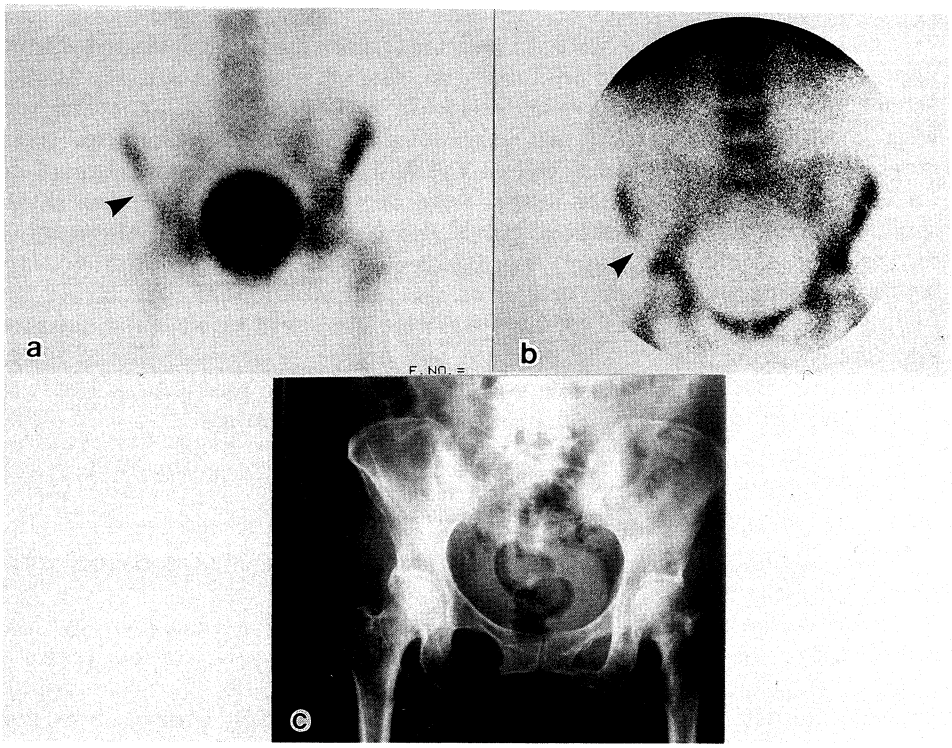

Fig. 1 a. Bone scintigraphy (^{99m}Tc-MDP) : Decreased accumulation of radioactivity is noted in the right ilium.
b. Bone-marrow scintigraphy (^{99m}Tc-sulfur colloid) : A clear-cut cold defect is noted in the marrow of right ilium.
c. Bone radiogram of the pelvis : Osteoporotic change can be detected.

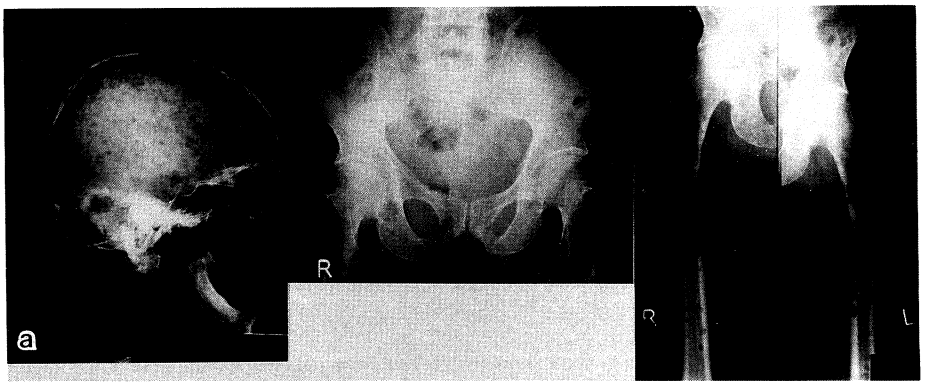

Fig. 2 a. Bone radiogram of the skull, pelvis and femur : Multiple punched-out lesions can be detected.

femurs (Fig. 2a), and bone scintigraphy was performed. Cold defects were shown in the skull, but images in other sites were nearly normal (Fig. 2b), even though bone roentgenograms indicated multiple bone lesions. Bone-marrow in the skull, lumbar, pelvis and femur was not depicted entirely on the ^{99m}Tc-sulfur colloid marrow scan (Fig. 2c).

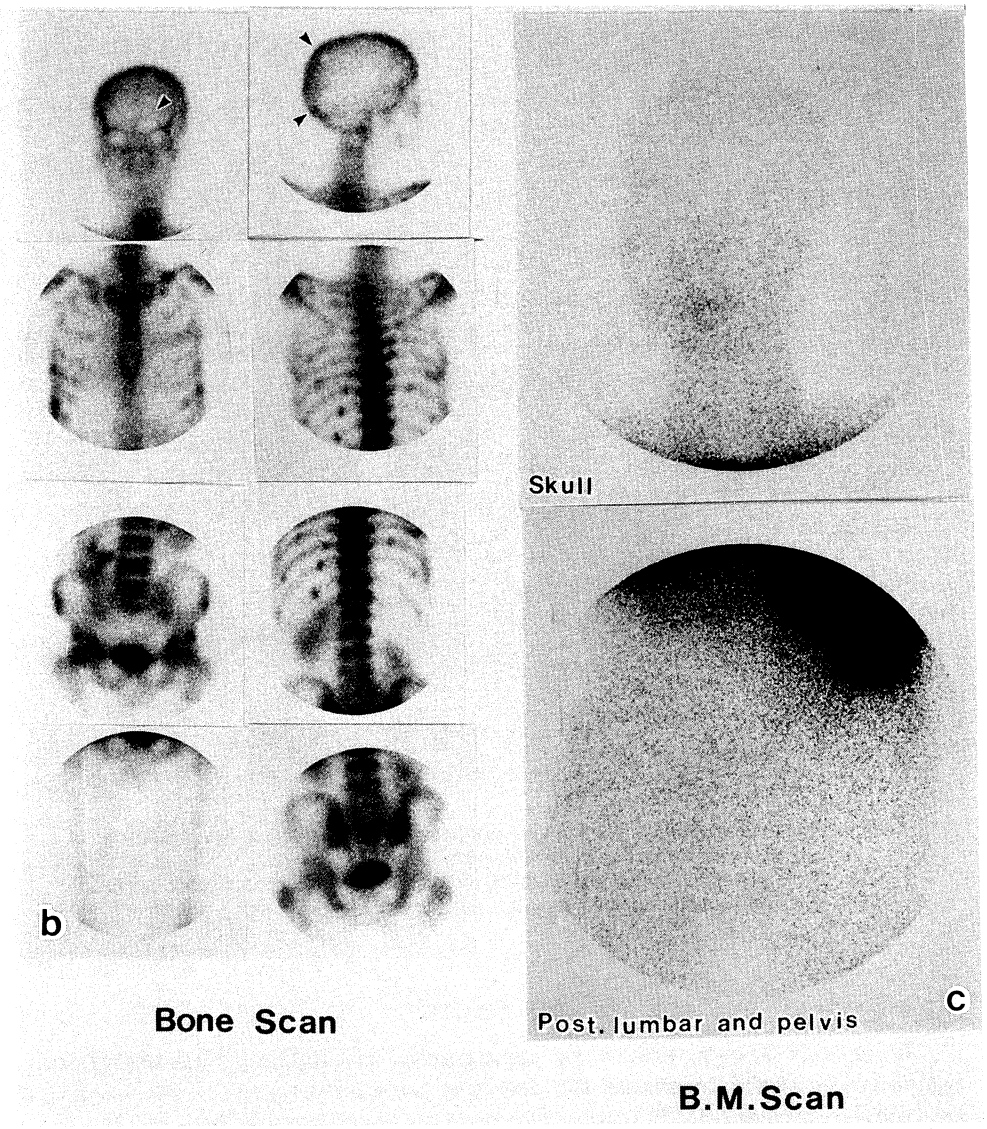

Fig. 2 b. Bone scintigraphy : Photon deficient areas are noted in the skull. Increased activity is noted in the ribs. However, apparent abnormality is not seen in the pelvis, spines and femur.
c. Bone-marrow scintigraphy : No accumulation in skull, lumbar and pelvic marrow is observed.

Case 3

A 49-year-old man noticed the walking pain in his left thigh and bone scintigraphy was performed. Cold defects were shown in the sternum and the right femur (Fig. 3a). After chemotherapy bone scintigraphic finding changed to the increased accumulation of radioactivity around the cold lesions (Fig. 3b). Bone-marrow scintigraphy showed a cold defect in the marrow of right femur (Fig. 3c). However, compared with pre- and post-chemotherapy, apparent change is not observed on marrow scan.

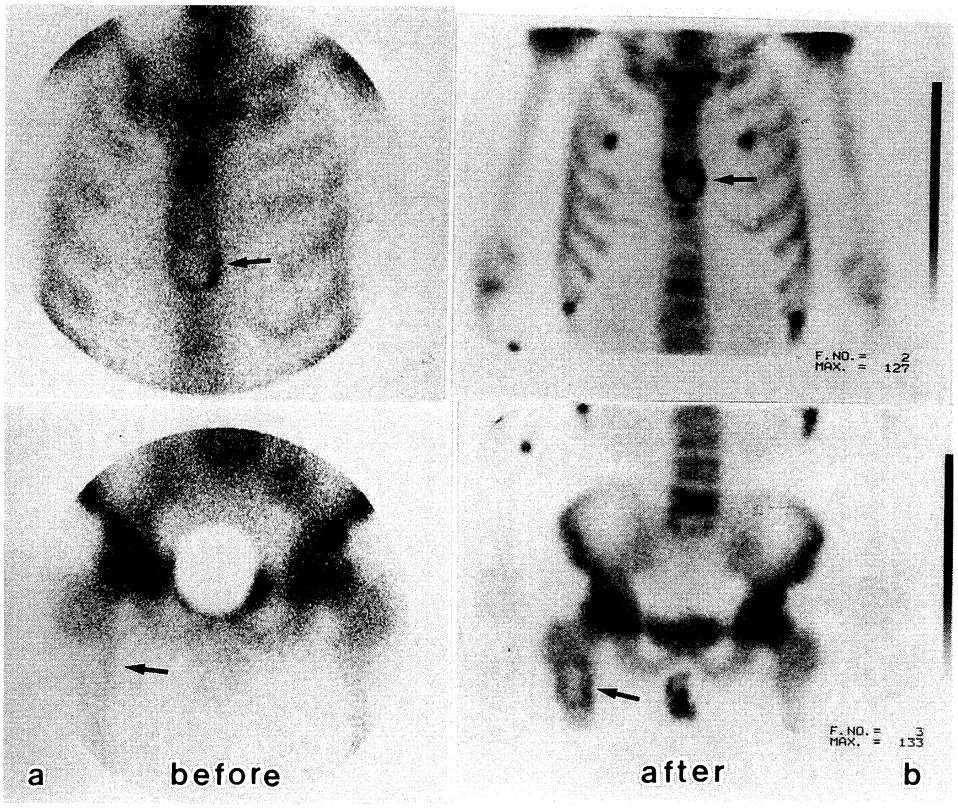

Fig. 3 a. Bone scintigraphy (before chemotherapy) : Decreased accumulation of radioactivity is noted in the sternum and right femur.
b. Bone scintigraphy (after chemotherapy) : Increased accumulation of radioactivity around the cold lesions (sternum and right femur) is noted.

DISCUSSION

It is well known that bone scintigraphy employing ^{99m}Tc-phosphorous compound is useful technique for detecting bone metastases.[6-8] Althcugh it is not completely clear how ^{99m}Tc-phosphorous compound accumulates in metastatic bone, the increased blood flow to bone and accelerated bone metabolism, namely, vigorous osteoblastic bone formation, have been proposed as possible mechanisms.[9,10] However, in multiple myeloma, showing osteolysis by some bone resorbing factors such as the osteoclast activating factor, and little osteoblastic bone formation,[11] accumulation of ^{99m}Tc-labeled phosphorous complexes is generally slight regardless of the existence of a neoplasm. As a result, normal or deficit images on bone scans are often obtained.[3] On the other hand, if the tumor cells could be controlled by treatment, normal bone formation would begin to take place, thus causing an increase in radionuclide accumulation on bone scan. Nevertheless, it is very difficult to differentiate whether the increased accumulation is due to effective treatment leading to new bone formation or due to a fracture caused by expansion of the tumor.

Bone-marrow scintigraphy has been reported to be useful in detecting bone

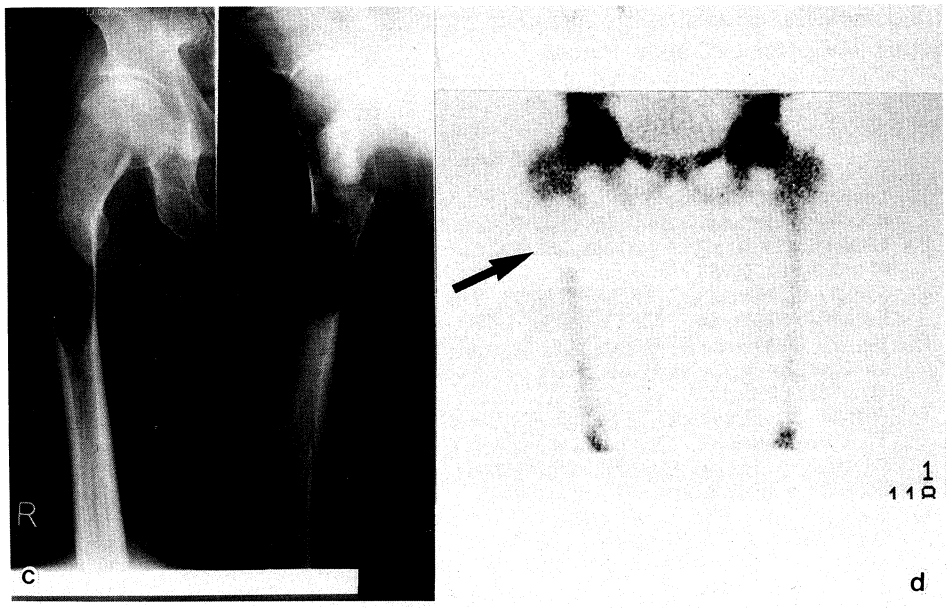

Fig. 3 c. Bone radiogram of the right femur : Massive osteolytic change can be detected in the right femur.
d. Bone-marrow scintigraphy : A cold defect is noted in the marrow of right femur. Composed with before and after chemotherapy, apparent change is not observed in the marrow.

metastases in cancer of the prostate.[5] Since bone scintigraphy reflects a local reaction in the bone and does not mean a specific accumulation in the neoplastic cells,[9,10] bone and bone-marrow scintigraphy used in combination should offer a clearer information of osseous lesions of multiple myeloma.

In the present study we performed bone and bone-marrow scintigraphy and compared these results of two scintigraphies in untreated and chemotherapeutically-treated patients with multiple myeloma. In most of the untreated patients, bone scintigraphy did not show the increased accumulations of the radionuclide in the lesions, but showed rather deficit images. By bone-marrow scintigraphy, well-defined deficit images of the lesions were revealed in the same areas as seen on roentgenograms, and furthermore the extent of the spread of the lesions could be observed clearly. In the treated patients, bone scintigraphy showed the increased accumulations of the radionuclide in the lesions and those surrounding areas. In the treated patients in whom chemotherapy appeared to be effective from clinical observations and laboratory findings, no deficit images were observed by bone-marrow scintigraphy. As an explanation of this discrepancy, it is unclear that whether reticuloendothelial cells in marrow repopulate following successful chemotherapy or senile bone change such as osteoarthritis complicating multiple myeloma occurred. Considering the fact, however, that in patients who had just begun chemotherapy and in whom no therapeutical effect had yet taken place, slight accumulations were observed around cold lesions on bone scintigraphy, and the deficit images on bone-marrow scintigraphy did not change, the discrepancy might be attributable to the regression of the tumor cells by the treatment.

From these results, it is shown that bone and bone-marrow scintigraphy are complemental each other and that their combined use is valuable in evaluating the extent of bone lesion.

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