Comparison of Radionuclide Bone Scans and Magnetic Resonance Imaging in Detecting Spinal Metastases

Edward Gosfield, III, Abass Alavi and Bruce Kneeland

Department of Radiology, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania

A retrospective comparison was made between ^{99m}Tc-MDP bone scans and corresponding spine MR images in 35 patients who had complementary studies within 2 mo. Bone scans were performed with planar imaging of the entire body and MRI was performed with a 1.5 tesla signal scanner using standard techniques with T1- and T2-weighted images. There were 18 male and 17 female patients diagnosed with cancer prior to these studies. Cancer diagnoses included 14 prostate, 12 breast, 1 bladder, 2 renal, 2 lung, 1 each of esophagus, melanoma, myeloma and adenocarcinoma of unknown primary cancer. Of the regions compared, 69 were positive for bony metastases by MRI and 63 regions by bone scans. Thirty-eight regions were concordantly positive and 56 regions concordantly negative. No patients with entirely positive bone scans were negative by MRI, but one patient was entirely positive by MRI but negative by a bone scan. At least one region was discordantly read in 21 patients. Distribution of positive regions was similar on bone scan and MRI. The greatest number and proportion of discordant readings occurred in the lumbar regions and more frequently in patients with prostate cancer. Considering its widespread availability and the ease of performing a whole-body survey for metastasis, radionuclide bone scanning remains the study of choice for initial evaluation of patients with cancer. However, MRI is an excellent complementary technique when bone scan findings are inadequate for answering clinical questions. MRI appears to be quite sensitive and probably more specific for metastasis in certain locations of the spine.

J Nucl Med 1993; 34:2191–2198

Radionuclide bone scans employing ^{99m}Tc-labeled phosphates are known to be more sensitive than plain radiographs in the detection of bone metastases. More than 50% of the bone mineral content must be lost before metastasis is evident on a radiograph (*1*) and cells growing in the marrow rather than the cortex reduce the likelihood of radiographic detection (*2*). Sensitivity of radiography varies with location, being more sensitive in the ribs and pelvis than the spine (*3*).

Received Dec. 30, 1992; revision accepted Jun. 25, 1993.

For correspondence and reprints contact: Abass Alavi, Div. of Nuclear Medicine, Dept. of Radiology, Hospital of the University of Pennsylvania, 3400 Spruce St., Philadelphia, PA 19104.

Bone scintigraphy has become the method of choice for initial detection of metastases, as well as the staging of patients with cancer. Additional imaging with conventional roentgenograms, CT (when bone scan findings are inconclusive) and more recently MRI, are being utilized to add specificity to the scintigraphic findings. In particular settings, such as myeloma, very aggressive lesions and lesions confined to marrow, bone scans have low sensitivity while fractures, degenerative disease and many other benign active disorders of the bones and joints may produce false-positive readings. The increasing availability of MRI has prompted its complementary use along with radionuclide scans in the detection of skeletal metastases. Our study was conducted to compare the results of MRI studies using T1- and T2-weighted spin echo images with radionuclide bone scans in the detection of vertebral metastases. The major aim of this study was to determine the complementary role of MR imaging to that of bone scintigraphy in the work-up of patients with suspected metastases to the spine.

MATERIALS AND METHODS

Patients were selected from the database of the department of radiology and were studied between September 1988 and September 1991. All patients were included if bone scans and MRI spine studies of the same area were performed within 2 mo of each other and were available for review. Thirty-five patients (18 males, 17 females) met the criteria for inclusion in the study. All patients had prior diagnoses of cancer: 1 adenocarcinoma of unknown primary cancer (F), 1 bladder (F), 1 esophagus (M), 2 lung (1 M, 1 F), 1 melanoma (M), 1 myeloma (F), 2 renal (1 M, 1 F), 13 breast and 14 prostate.

In general, bone scans were done as part of standard staging protocols after cancer diagnosis, for pain symptoms, follow-up of known metastases and for confirmation of equivocal or suggestive findings in other imaging modalities such as CT or plain films. Nine patients had bone scans done after MRI, 24 patients had MRI done after bone scans, and 2 patients had both studies on the same day. Six patients had MRI done after entirely negative bone scans, with one additional MRI done after a bone scan questionably positive in one region only.

Bone scans were obtained using a large field of view gamma camera, equipped with a parallel-hole, low-energy collimator, 3 to 4 hr after intravenous injection of 25 mCi (925 MBq) of ^{99m}Tc-MDP. Images of the entire body were acquired in multiple projections. The various anatomic sites of the trunk were imaged for

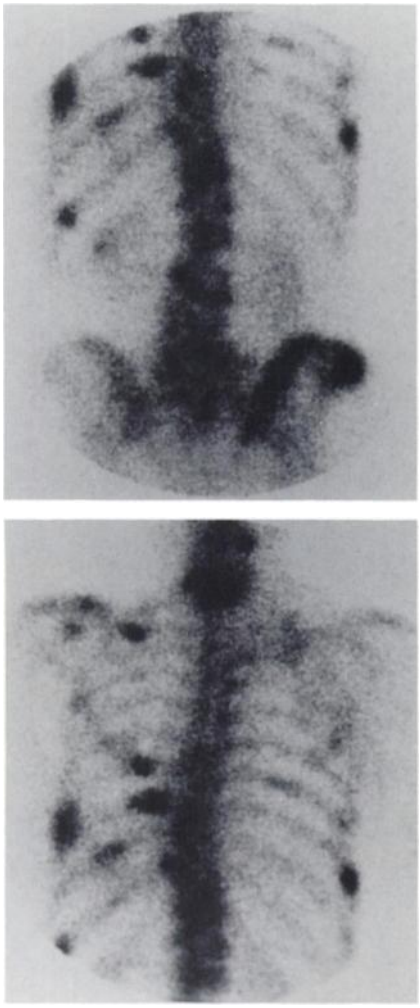


FIGURE 1.
Bone scan of a patient with breast cancer. Metastases throughout all regions of the spine (also in the ribs, skull, pelvis, clavicles and scapula).

500,000 counts each, and the skull and extremities were scanned for 250,000 counts. The first image of the arms was done for 250,000 counts, while the second scan was done for the same amount of time as it took for the first study. The same protocol was followed for other images where both sides of the body could not be included in the same view.

MR studies were performed due to symptoms such as low back pain, signs of cord compression, or infrequently, due to suspicion of metastases in the context of negative bone scans. MR studies were performed with a 1.5 tesla signal scanner using standard pulse sequences, with TR times of 500 msec and TE times of 20 msec. All patients were studied with T1-weighted spin echo sequences obtained in the sagittal plane. Twenty of the patients were studied with T2-weighted spin echo sequences in the sagittal plane. A small number of patients were studied with T2* weighted gradient echo sequences also in the sagittal plane.

The MR studies and bone scans were read independently by an experienced orthopedic radiologist (MR) and an experienced nuclear physician (bone scan) who were blind to diagnosis, history and the findings of other studies. The spine was divided into cervical, upper thoracic (T1–4), middle thoracic (T5–8), lower thoracic (T9–12), upper lumbar (L1, 2) and lower lumbar (L3–5) regions. Each patient's readings were scored by region as positive, questionable or negative for metastatic involvement and in some cases the MR regions were scored as nondiagnostic for technical reasons such as patient movement or poor technical quality.

Bone scan regions were read positive using the accepted subjective criteria such as the intensity of uptake, focality, number, location and pattern of distribution. An area was considered abnormal when its uptake of tracer was increased compared to adjacent or contralateral structures. Only regions examined by both MRI and scintigraphic studies were compared. Scintigraphic findings of bony metastases in areas outside the spine were also noted to demonstrate the prevalence in our sample of this clinically important condition which can conveniently be evaluated on a bone scan. We felt this would add another dimension to the evaluation of patients with cancer in whom the additional information of the bone scan may play a role in their management.

The criteria for the MRI diagnosis of metastases were the presence of a well defined focus of low signals on the T1-weighted images and high signal intensity on T2-weighted spin echo or gradient echo sequences. In the absence of T2-weighted or gradient echo sequence images, a well defined focus of low signals on the T1-weighted images was interpreted as representing metastasis. Ill-defined foci of low signals on T1-weighted images for which no T2-weighted images were obtained were considered to be equivocal (i.e., questionable) for the diagnosis of metastases. In these circumstances, the distinction between metastases and hematopoietic marrow can be difficult.

Corresponding MRI and bone scan interpretations were considered concordant in a region if both readings were positive, questionable or negative for metastasis and discordant if the readings differed. Regions read as nondiagnostic on MRI were not included in the final analysis. Figures 1 and 2 show the appearance of the scans of a patient who read positive in all regions on both bone scan and MRI.

Although histopathological findings are the only proof of metastatic disease in a particular location, it is usually impractical and unnecessary for the management of the patient to require such data in most situations. However, confirmation of findings was sought in discordant cases using other correlative modalities and pathological confirmation when available. Subsequent progression on repeated bone scans (i.e., worsening or newly noted

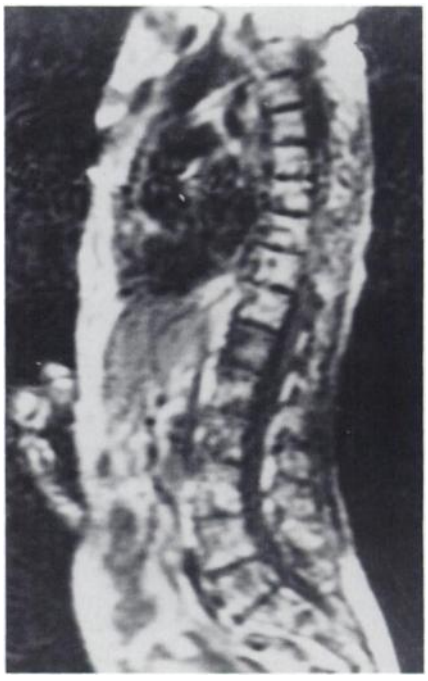


FIGURE 2.
MRI. Metastases in all regions of the spine (T1 image).

TABLE 1
Bone Scan Readings By Region

Region	Positive	Questionable	Negative	Total
Cervical	5	1	29	35
Upper thoracic	15	1	19	35
Middle thoracic	15	0	20	35
Lower thoracic	18	2	15	35
Upper lumbar	15	0	20	35
Lower lumbar	10	1	24	35
Total	78	5	127	210

activity), or positive findings for metastasis on plain films or computed tomographic scans (CT) of bones were also considered confirmatory, as were repeatedly positive MRI findings on subsequent studies. Because of the relative insensitivity of plain film for metastasis (compared to bone scintigraphy and MRI) negative radiographic bone films were not considered as proof of the absence of metastatic disease.

RESULTS

Of the 210 total vertebral regions studied by bone scan (Table 1), 157 had technically diagnostic MRI studies. Considering only these 157 technically comparable regions, 65% of the patients had at least one region read positive on bone scan, while 35% of the patients had no region read positive on bone scan. Bone scans were positive in 63/157 (40%) of the technically comparable regions and negative in 88/157 (56%) of such regions.

Of the breast cancer patients, 75% had at least one technically comparable region read positive and 33% had no positive regions on bone scan. Breast cancer patients had 26/60 (43%) of comparable regions positive and 31/60 (52%) negative on bone scan. Of the prostate cancer patients, 69% had at least one comparable region read positive while 23% had no region read positive on bone scan in a region technically diagnostic on MRI. Prostate cancer patients had 28/52 (54%) of diagnostically comparable regions positive and 24/52 (46%) negative on bone scan.

Metastases outside the spine were noted on the bone scans of 18 (51%) of the 35 patients. These included patients with adenocarcinoma of unknown primary cause, esophageal cancer, myeloma, bladder cancer (one each), 6 (50%) of the 12 breast cancer patients and 8 (57%) of the 14 prostate cancer patients. Fifteen (65%) of the 23 patients with one or more regions positive on bone scans had extra spinal metastases, while 3 (25%) of the 12 patients with no region read positive on bone scans had extra spinal metastases.

MRI scans were performed on 173 regions, of which 157 (90%) were considered technically diagnostic. Thirty-seven regions which had been studied by bone scan were not included in the correlative MRI studies. Sixteen regions studied by MRI were considered nondiagnostic for technical reasons such as patient movement or poor image quality resulting from inadequate depth penetration from the coils in obese patients. One study was nondiagnostic in all five regions on MRI due to motion artifact.

Sixty-nine regions on MRI were considered positive for metastatic involvement (44% of the diagnostically adequate regions) while 76 were considered negative for metastatic involvement (48% of the diagnostically adequate regions). Twelve regions were questionable for metastasis (8%) (Table 2).

At least one region read positive for metastasis on MRI in 71% of patients with technically diagnostic studies. No region read positive for metastasis in 29% of these patients. Two patients had six regions read positive, five patients had five regions read positive, two patients had four regions read positive, two patients had three regions read positive, five patients had two regions read positive and eight patients had one region read positive.

More patients were absolutely and relatively considered to have metastatic involvement of the spine by MRI than by bone scan. Table 3 summarizes the overall prevalence on bone scans and MRI of positive and negative regions as well as by type of primary cancer. Bone scans and MRI detected the same number and percentage of breast cancer patients with metastases, whereas more prostate cancer patients with metastases were absolutely and relatively identified by MRI.

Overall, the distribution of positive regions was similar on bone scans and MRI with the greatest number in the lower thoracic region and the least in the cervical region on both modalities. Fewer lumbar metastatic regions were identified on bone scans than by MRI with the greatest difference in the lower lumbar region.

Table 4 summarizes the concordance or lack of it in regions read definitely positive or negative on both bone scans and MRI. Of the 157 regions considered diagnostically adequate, 141 (90%) were read definitely positive or

TABLE 2
MRI Readings By Region

Region	Positive	Questionable	Negative	Excluded	Nondiagnosed regions	Diagnostic regions
Cervical	6	2	12	13	2	20
Upper thoracic	9	2	15	5	4	26
Middle thoracic	13	2	11	6	3	26
Lower thoracic	15	2	9	6	3	26
Upper lumbar	13	3	15	3	2	30
Lower lumbar	13	2	14	4	2	29
Total	69	13	76	37	16	157

TABLE 3
Prevalence of Positive and Negative Regions

	Bone scans in diagnostic MRI regions (%)	MRI in diagnostic regions (%)
Patients:		
Patients with at least one positive region	65	71
Patients with no region positive	35	32
Breast carcinoma patients with at least one positive region	75	75
Prostate carcinoma patients with at least one region positive	69	85
Regions:		
Positive regions	(63/157) 40	(69/157) 44
Negative regions	(88/157) 56	(76/157) 48
Breast carcinoma regions positive	(26/60) 43	(29/60) 48
Breast carcinoma regions negative	(31/60) 52	(26/60) 43
Prostate carcinoma regions positive	(26/52) 52	(23/52) 44
Prostate carcinoma regions negative	(24/52) 46	(22/52) 42
Adenocarcinoma regions positive	(5/5) 100	(4/5) 80
Adenocarcinoma regions negative	(0/5) 0	(1/5) 20
Esophagus regions positive	(1/5) 20	(5/5) 100
Esophagus regions negative	(4/5) 80	(0/5) 0
Melanoma regions positive	(1/6) 17	(5/6) 83
Melanoma regions negative	(5/6) 83	(1/6) 17
Myeloma regions positive	(0/2) 0	(2/2) 100
Myeloma regions negative	(2/2) 100	(0/2) 0
Renal carcinoma regions positive	(3/10) 30	(1/10) 10
Renal carcinoma regions negative	(7/10) 70	(9/10) 90
Bladder carcinoma regions positive	(0/5) 0	(0/5) 0
Bladder carcinoma regions negative	(4/5) 80	(5/5) 100
Lung carcinoma regions positive	(0/12) 0	(0/12) 0
Lung carcinoma regions negative	(12/12) 100	(12/12) 100

negative on both types of study with 38/157 (24%) read concordantly positive, 56/157 (36%) read concordantly negative, 18/157 (11%) positive on bone scan and negative on MRI (Figs. 3 and 4), and 29/157 (18%) negative on bone scan and positive on MRI (Figs. 5 and 6). Of the regions compared, 47/157 (30%) were unequivocally discordant.

Of the 35 patients studied, 14 (40%) had no discordantly read regions, while 21 (60%) had at least one region unequivocally positive or negative on either bone scan or MRI and discordant between the two. In all patients (but one) with multiple discordant regions, the discordances were of one type per patient (i.e., bone scan −, MRI +; or bone scan +, MRI −) for regions scored positive or negative. Seven patients had one discordant region, eight had two discordant regions, two had three discordant regions, three had four discordant regions and one had six discordant regions (entirely negative on bone scan while entirely positive on MRI). Six patients (17%) had at least one positive or negative region with a corresponding region scored as questionable in the other imaging modality.

The greatest number and proportion of discordant readings were obtained in the lower lumbar regions, most fre-

TABLE 4
Comparison of Regions Read Positive and Negative

	Bone scan + MRI +	Bone scan − MRI −	Bone scan + MRI −	Bone scan − MRI +	Number of regions compared (positive, negative or questionable)	Discordant regions (%)
Cervical	1	12	0	4	20	(4/20) 20
Upper thoracic	6	10	5	3	26	(8/26) 31
Middle thoracic	8	8	3	5	26	(8/26) 31
Lower thoracic	11	5	3	4	26	(7/26) 27
Upper lumbar	8	9	5	5	30	(10/33) 33
Lower lumbar	4	12	2	8	29	(10/29) 34
Total	38	56	18	29	157	(47/157) 30

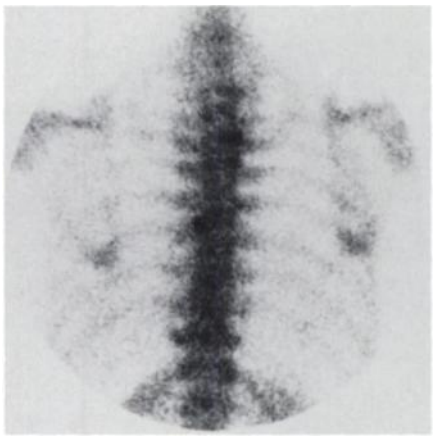
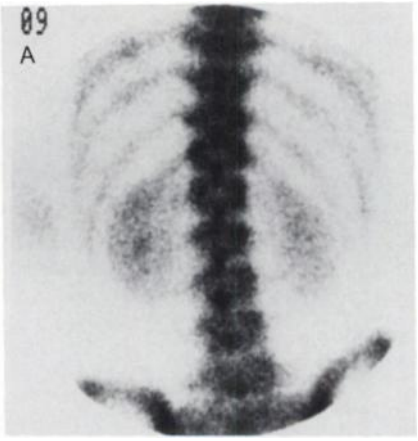


FIGURE 3. Bone scan. Metastases in T3 Rt pedicle, T4 Rt and T7 Lt pedicle; L5 DJD, no other abnormalities noted. The patient had breast cancer and was considered clinically free of metastases in the T and L spine.

quently occurring in prostate cancer patients, which were negative on bone scan and positive on MRI. The lowest number and proportion of discordant regions were obtained in the cervical region where there were no regions which were positive on bone scan and negative on MRI while four patients had negative bone scan readings with positive MRI findings. The distribution of discordant (+ or −) regions by primary diagnosis is shown in Table 5, as well as the percentage of patients with discordant regions in each type of primary cancer. Tables 6 and 7 show the distribution of discordant unequivocal readings in breast and prostate cancer patients.

In six patients there were concurrent (CT), or subsequent (plain films, MRI) imaging studies demonstrating false-negative readings on bone scan interpretation in 14 total regions (two patients with prostate cancer, two with breast cancer, one esophageal cancer and one melanoma). Subsequent imaging (repeat bone scan or MRI) provided



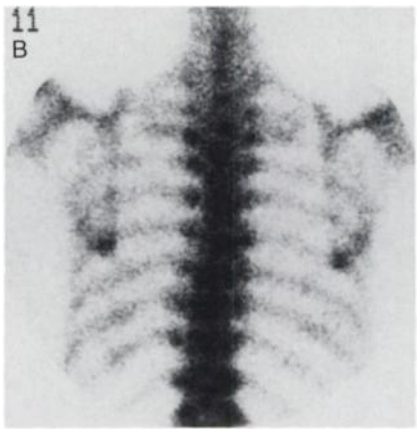


FIGURE 5. Bone scan shows no metastases. The patient was a young woman with aggressive breast cancer of high histological grade considered eventually to involve virtually every bone in the body. She had received radiotherapy to the L-spine and was receiving chemotherapy at the time of these studies (plain films were negative).

evidence of false-positive bone scan interpretation in three total regions in two patients with breast primaries.

One renal cancer patient with a Schmorl node diagnosed on MRI was read positive on bone scan (there was no other confirmation available) (Figs. 7 and 8). Another patient

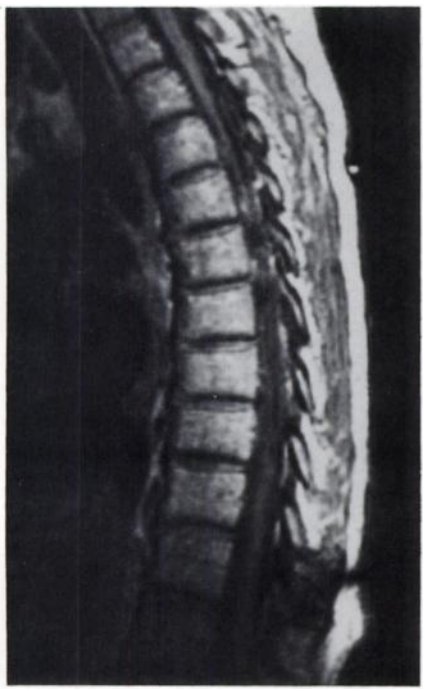


FIGURE 4. MRI. No definite metastases.

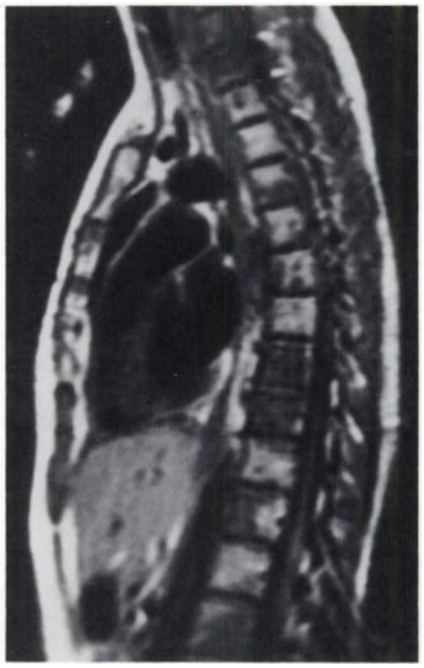


FIGURE 6. MRI shows diffuse metastases to all regions.

TABLE 5
Number of Discordant Regions per Patient, Number and Percent of Patients with Discordant Regions by Primary Diagnosis

Diagnosis	Number of Discordant Regions						Total discordant regions (%)
	1	2	3	4	5	6	
	Number of patients						
Breast	1	4	1	0	0	1	7 (58)
Prostate	5	2	1	1	0	0	9 (60)
Renal	0	2	0	0	0	0	2 (100)
Adenoca	1	0	0	0	0	0	1 (100)
Esophagus	0	0	0	1	0	0	1 (100)
Melanoma	0	0	0	1	0	0	1 (100)
Myeloma	0	1	0	0	0	0	1 (100)

with a Schmorl node diagnosed by MRI was read as questionable for metastasis on bone scan.

A patient with a negative bone scan in a region scored questionable for metastases on MRI had a subsequent MRI within the same month read as probable benign compression fracture. A patient with a positive bone scan in five regions and negative MRI in two of those regions showed the original and two new lesions on a bone scan 6 mo later, but only a new compression fracture in one of the originally negative MRI regions on repeat MRI 7 mo later. This may represent a false-negative MRI. One patient with three discordant positive bone scan regions read as questionable on MRI received palliative radiation therapy for pain in two of those regions within the preceding 3 mo and improved clinically following the therapy, consistent with a true-positive bone scan. For the other patients, specific regional confirmation was not available by imaging or records of clinical follow-up.

DISCUSSION

Avrahami et al. (*4*) studied 40 patients with histologically proven primary tumor referred for MRI examination due to progressive back pain. All patients had normal CT of the thoracic or lumbar spine and normal findings on radionuclide bone scan. Twenty-one of these patients had abnormal MRI findings which were histologically proven to be metastases. No correlation between type of primary cancer and the signal intensity of lesions on MRI was found. They noted a mosaic pattern of multiple focally increased and decreased signal intensities in three patients with multiple myeloma.

Delbeke et al. (*5*) found additional metastatic vertebral sites by MRI in 18% of 56 patients with known malignancy studied by MRI and bone scanning with an overall discordance rate of 23%. Three patients had a positive bone scan with negative MRI, with two of the bone scans contradicted by CT. Delhike et al. believed that hemangiomas and Schmorl's nodes had the same MR signal as metastases and could be mistaken for metastases. Metastases missed on bone scans were from rhabdomyosarcoma, germ-cell tumor and Hodgkins disease, each of which may produce bone metastases with normal diphosphonate uptake (*6*).

Frank et al. (*7*) studied 11 patients with biopsy proven primary bone tumors and 95 patients with known metastatic disease. Twenty-eight percent of their patients had an MRI lesion not seen on a bone scan with an overall discordance rate of 31%. They found no difference in the distribution of abnormalities by modality. Two patients had a positive bone scan with negative MRI considered on later imaging to be stress fracture versus compression fracture. One patient had a positive bone scan with questionable MRI which was shown by further imaging studies to be metastasis (from colon cancer).

Algra et al. (*8*) studied 71 patients with histologically proven skeletal metastases and clinical or radiographic signs of vertebral metastasis. They found additional metastatic vertebrae by MRI, compared to bone scan, in 69% of patients. There was no specific MRI pattern associated with a particular primary cancer. The distribution of abnormalities over the spine was similar on bone scans and

TABLE 6
Discordant Readings by Region in Breast Cancer Patients

Breast cancer patients	Bone + MRI −	Bone − MRI +	Not included on MRI	MRI Nondiagnosed	MRI ?	Bone ?
Cervical	0	2	4	0	1	0
Upper thoracic	2	2	1	0	1	0
Middle thoracic	2	2	2	0	1	0
Lower thoracic	1	2	2	0	0	1
Upper lumbar	1	1	1	0	1	0
Lower lumbar	1	2	1	1	1	1
Total	7	11	11	1	5	2

TABLE 7
Discordant Readings by Region in Prostate Cancer Patients

Prostate cancer patients	Bone + MRI −	Bone − MRI +	Not included on MRI	MRI Nondiagnosed	MRI ?	Bone ?
Cervical	0	0	4	2	1	1
Upper thoracic	2	0	3	4	1	1
Middle thoracic	0	1	3	3	1	0
Lower thoracic	1	1	3	3	1	0
Upper lumbar	2	1	2	2	2	0
Lower lumbar	1	5	2	1	1	0
Total	6	8	17	15	7	2

MRI with lumbar and lower thoracic abnormalities representing the most frequent sites as shown by autopsy and previous bone scan literature (*9*). Where histological confirmation was available (12 patients) for lesions found on MRI and negative on corresponding bone scans, biopsies showed metastases. A Schmorl's node identified by MRI yielded a false-positive bone scan reading and a patient with breast cancer and a negative bone scan had diffusely abnormal vertebrae by MRI. These authors felt that MRI was more sensitive than bone scans especially in cases of diffusely abnormal signal intensity on MRI.

Mehta et al. (*10*) described a case of male breast cancer with extensive metastatic disease in the cortex and bone marrow of the spine seen on CT and MRI which was not evident on bone scintigraphy. Khurana et al. (*11*) reported a case of liposarcoma with biopsy proven metastasis to the lumbar vertebrae detectable only by MRI with normal CT and bone scan. Kattapuram et al. (*12*) reported cases of liposarcoma and spindle cell sarcoma having biopsy proven metastasis to vertebral bodies seen as focally abnormal areas of signal intensity on MRI with normal findings on bone scintigraphy.

A number of explanations may account for the higher sensitivity of MRI than bone scintigraphy for the detection of vertebral metastases. Hematogenously seeded intramedullary metastases may produce lesions by marrow replacement detectable on MRI before adequate reaction takes place in the adjacent bone to be detected scintigraphically or radiographically (*8*). The high contrast between fat and metastasis allows early demonstration of metastasis on MRI as soon as macroscopic lesions have been developed in the marrow. However, osteoblastic response is necessary for metastasis to result in increased activity on bone scan (*9*). This is a relatively slow process and may require several weeks before it can be visualized on bone scan. In addition, the avidity of bone for radionuclide depends on the local metabolic state which is influenced by the activity of the disease and the balance of blastic versus clastic reaction. In addition to reduction of uptake in response to therapy (following possible initial "flare" phenomenon), there may be a reduction of tracer uptake in rapidly progressive disease where there is little chance for new bone formation (*13*).

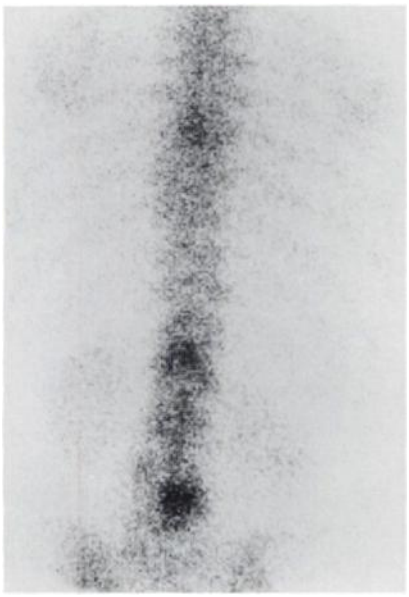


FIGURE 7. Bone scan shows metastases to T8, L2, L4. The patient had renal cancer and was considered clinically free of metastasis in planning further treatment.

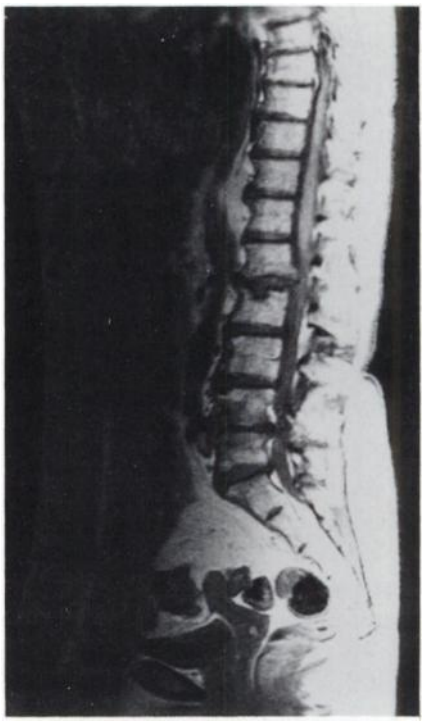


FIGURE 8. MRI shows no definite metastases to L2 Schmorl node.

In general, sizable metastases (at least 1 cm in size) are detectable in areas optimal for high resolution imagery with planar scintigraphy. The latter is particularly applicable to the lumbar and to some extent the thoracic spine. Planar imaging is considered suboptimal for detecting lesions that are located in the vertebral bodies. SPECT imaging is essential for this purpose and unfortunately was not employed by the investigators who compared MRI and bone scintigraphy in the spine.

Our results demonstrate a higher sensitivity for MRI in detecting vertebral metastases (71% of patients, 44% of regions) than for bone scans (65% of patients, 40% of regions). Where confirmation was available through other imaging studies, the data support the high accuracy of MRI. The available clinical follow-up data also support the overall accuracy of the MRI diagnoses. In the two cases of Schmorl's node diagnosed accurately by MRI, the bone scan was read positive or questionable for metastasis. These findings are consistent with previously published studies. In another patient, the studies contradicting our MRI findings were obtained 6–7 mo later and may represent progression subsequent to the earlier scan.

Our overall degree of discordance and its pattern of distribution are quite consistent with the previously published reports dealing with comparisons of MRI and bone scans. Although confirmation was not available for the discordant reading in our myeloma patient, it is accepted that bone scans cannot reliably exclude metastasis in this disease. One of the breast cancer patients we studied provided an example of a false-negative bone scan in a poorly differentiated high-grade tumor, where progression of disease, observable by marrow change on MRI, may outstrip the reactive calcification detectable by bone scan.

Our finding of greater discordance in the lumbar region (33% in upper lumbar, 34% in lower lumbar) may be due to the composition of the study population. Lumbar spine metastasis is more common among prostate than breast cancer patients (the two groups comprising the preponderance of our patient sample), and it may be related to the pattern of physiological spread in these two types of malignancy. We were unable to associate our findings with the "flare up" phenomenon seen in patients who are responding to chemotherapy. We believe this phenomenon should have increased the sensitivity of bone scintigraphy compared to MRI which was not noted in this comparison.

Bone scans remain the study of choice for initial screening for metastasis, because of their overall high sensitivity, lower cost, availability and ability to assess the entire body conveniently. Scintigraphic images can be obtained with much less difficulty in patients whose cooperation is essential for obtaining interpretable studies. MRI is a useful complementary study in patients with equivocal or negative bone scan findings in the context of high clinical suspicion or in patients with a positive bone scan and low clinical suspicion for metastases. In the presence of suspicious MRI abnormalities, an attempt at diagnostic biopsy may be further justified.

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EDITORIAL

Is the Whole Really the Sum of the Parts?

The article by Gosfield et al. (*1*) in this issue of the *Journal* provides insight into the comparison of MRI and bone scintigraphy in patients with a diagnosis of cancer and the identification of metastatic disease. The largest previous study was by Avrahami et al. (*2*) who reported that MRI of the spine detected metastases in 21 of patients with histologically proven tumors and back pain. In this study, CT and plain films were normal and bone scintigraphy was *equivocal*. A number of other small series have been published in which MRI was able to pick up additional metastatic foci in comparison to bone scintigraphy (*3,4*). Gosfield et al's. study concentrates on the sensitivity, specificity and accuracy of MRI versus bone scintigraphy, yet they are unable to provide numbers. Even though the study was retrospective, the patients were selected randomly, i.e., cancer patients were selected who had bone scintigraphy and MRI of the spine within 2 mo of each other.

Received Aug. 31, 1993; accepted Aug. 31, 1993.
For correspondence or reprints contact: Jerry W. Froelich, MD, Radiology Imaging Associates, Swedish Medical Center, 501 E. Hampden, Englewood, CO 80150.