Clinical Significance of Solitary Rib Hot Spots on Bone Scans in Patients with Extraskeletal Cancer: Correlation with Other Clinical Manifestations

**Purpose:** Bone scans showing solitary hot spots in the ribs pose diagnostic problems in patients with proved extraskeletal cancers. The authors wanted to determine the importance of solitary rib lesions and their correlation with other clinical manifestations.

**Materials and Methods:** The study included 199 patients with solitary rib hot spots on their bone scans. The follow-up radiographic and scintigraphic images were reviewed to determine their origin. The correlation between the occurrence of a malignant rib lesion and clinical data were determined using Pearson chi-square tests.

**Results:** Ninety-three patients had an established cause of the rib hot spot. Eleven (11.8%) had a solitary malignant rib hot spot and 82 (88.2%) had a solitary benign rib hot spot. None of the hot spots at costochondral junctions were malignant. Of the 11 patients with proved metastatic rib hot spots, 1 of 11 (9.1%) had localized bone pain, 5 of 6 (83.3%) were concordant with primary tumors, 4 of 7 (57.1%) had elevated tumor markers, and 5 of 11 (45.5%) had concurrent extraskeletal metastases. For the 82 patients with benign rib hot spots, the figures were 2 of 82 (2.4%), 43 of 57 (75.4%), 26 of 69 (37.7%), and 19 of 82 (23.2%), respectively. Statistical analysis did not show a significant correlation between the incidence of metastases in solitary rib hot spots and clinical manifestations.

**Conclusions:** Most solitary rib hot spots on bone scans were benign. The interpretation of a solitary hot spot in the ribs is difficult even with the help of these clinical manifestations. Follow-up bone scintigrams or radiographs are needed for further investigation of solitary rib hot spots.

**Key Words:** Bone Scintigraphy, Hot Spot, Metastasis, Rib.
De graphs; and 2) progression evident on follow-up bone scans, bone scan abnormality, either on initial or subsequent radio-

Radiographs and Clinical Review

The images were initially interpreted by two nuclear medicine physicians and reviewed by one of the authors. The location of the rib abnormality was recorded as being on the anterior, lateral, or posterior aspect or in the costochondral junction. The rib hot spots were defined as concordant if they were located on the same side as primary cancers of the breast, lung, or kidney. As in previous studies, lesion intensity was documented as increased, decreased, unchanged, or completely resolved compared with radioactivity at an adjacent or contralateral site of normal bone. The presence of new lesions on follow-up bone scans showing widespread metastatic disease was also noted.

Radiographs and Clinical Review

The findings of all available radiologic studies of each abnormal rib lesion site were reviewed. Findings of plain radiographs or computed tomography were classified as bone destruction (a blastic or lytic lesion with characteristic features of metastatic disease), fractures, other benign bone lesions, or normal appearance. In addition, we documented all scintigraphic and radiographic reports of distant extraskeletal (e.g., lung, liver, or brain) metastases. We reviewed the medical charts of all these patients to the date of their last follow-up at our hospital. The results of tumor markers in the period of follow-up, the site of primary cancer, and extraskeletal metastases were recorded.

Data Analysis

The diagnostic criteria for metastatic rib hot spots were 1) the presence of a pattern of bony destruction at the site of the bone scan abnormality, either on initial or subsequent radiographs; and 2) progression evident on follow-up bone scans, defined as increased lesion intensity or extension at the original locus with the development of multiple new focal abnormalities.

Confirmation of a benign rib hot spot was based on one or more of the following: 1) an abnormal radiographic pattern in the same area indicative of a benign disease (e.g., a simple fracture); 2) imaging follow-up of at least 18 months without evidence of metastatic disease, or lack of a progressive process at the lesion site; and 3) without any special treatment, remission of the rib abnormality on follow-up bone scans. Pearson chi-square tests were used to explore the relation between the incidence of malignancy of the rib hot spot and other clinical data, such as age, sex, presence of bone pain, elevation of tumor markers, association of the rib hot spots with a primary tumor, and the occurrence of extraskeletal metastases. The level of statistical significance was set at \( P \leq 0.05 \).

Results

Patients

One hundred ninety-nine patients met the inclusion criteria. Further review led to the deletion of 106 patients: 8 because of an abnormality seen on studies performed before January 1, 1997; 50 because of lost follow-up and no available radiographic or clinical data; and 48 because imaging or clinical follow-up was insufficient to establish or confirm the cause of the rib abnormality.

In the remaining 93 patients (ages 52.1 \pm 13.4 years; age range, 13 to 81 years; median age, 52 years; 61 women, 32 men), a final diagnosis could be established by the follow-up radiographic or scintigraphic images. The primary site was breast cancer in 48 (51.6%), lung cancer in 12 (12.9%), head and neck cancer in 11 (11.8%), urogenital cancer in 8 (8.6%), colon cancer in 5 (5.4%), hepatoma in 3 (3.2%), and other cancers (lymphoma, gastric cancer, germ cell tumor, uterine sarcoma, and cholangiocarcinoma) in 6 (6.5%).

Origin of the Lesions

According to the diagnostic criteria, the origin of 11 of the 93 lesions (11.8%) was metastatic disease. Radiographs showed bony destruction in the same area as the scintigraphic abnormality in 8 (Fig. 1), and progression of the original solitary rib hot spots with multiple bone metastases in 3 follow-up bone scans. The primary diseases in these 11 patients were lung cancer (n = 5), breast cancer (n = 3), hepatoma (n = 2), nasopharyngeal cancer (n = 2), and carcinoma of the prostate (n = 1). The remaining 82 (88.2%) rib hot spots were benign: 11 were attributed to simple fracture as manifested on plain radiographs with healing evidence on follow-up radiographs; 6 resolved without special treatment; and 65 appeared normal radiographically after at least 1.5 years of follow-up (mean, 31.0 \pm 11.2 months; range, 18 to 76 months). Table 1 shows the relation between the primary cancer and the origin of the solitary rib hot spots.

Location of Rib Abnormalities

Thirty-five (37.6%) of the solitary rib hot spots were in the posterior aspect, 32 (34.4%) were in the lateral aspect, 21 (22.6%) were in the anterior aspect, and 5 (5.4%) were in the costochondral junction. Six (54.4%) of the 11 metastatic rib hot spots were in the posterior portion of the rib, 4 (36.4%) were in the lateral portion, and 1 (9.1%) was in the anterior portion. None of the five hot spots in the costochondral junction was metastatic. The incidences of cancer were 17.1% (6 of 35), 12.5% (4 of 32), 4.2% (1 of 21), and 0% (0 of 5), for a

Tc-99m MDP Bone Scan

Before being injected with radiotracer for bone scans, all patients had been queried about any recent surgery, trauma, radiotherapy, and bone pain. The radionuclide bone scans were performed 3 to 4 hours after the intravenous injection of 740 MBq (20 mCi) Tc-99m MDP. Whole-body images were obtained using gamma cameras equipped with low-energy, high-resolution collimators at a scan speed of 15 cm/minute. Selected spot views of abnormal sites were acquired as high-resolution collimators at a scan speed of 15 cm/minute. Obtained using gamma cameras equipped with low-energy, high-resolution collimators at a scan speed of 15 cm/minute.
solitary rib hot spot in the posterior, lateral, anterior aspect, and costochondral junction, respectively.

Clinical Manifestations

Pain. Three patients had bone pain related to the solitary rib hot spot. Of the 11 patients with metastatic rib lesions, only the one patient (9.1%) with hepatoma had localized bone pain (right lower rib area). The other 10 patients had no symptoms. Of the 82 patients with benign rib lesions, 2 (2.4%) (one with breast cancer and the other with colon cancer) felt bone pain in their rib hot spots shown on bone scans. In all, only 3 of 93 (3.2%) patients had definite symptoms related to their rib lesions.

Concordance of Rib Lesions with Primary Tumors.

Forty-eight patients had breast cancer (18 on the left side, 29 on the right, and 1 on both), 12 had lung cancer (6 on the left side and 6 on the right), and 4 had carcinoma of the right kidney. In 63 of these patients (the patient with bilateral breast cancer was excluded), bone scans revealed 48 (76.2%) concordant rib hot spots, 5 of which (in 2 patients with breast cancer and 3 with lung cancer) were metastatic. The incidence of concordant rib hot spots in the metastatic rib lesion group was 83.3% (5 of 6), and in the benign rib lesion group the incidence was 75.4% (43 of 57).

Tumor Markers.

Tumor markers had been recorded on the clinical charts of 76 of the 93 (81.7%) patients, including the 7 with proved metastatic rib hot spots and 69 with benign rib hot spots. Thirty patients had elevated tumor markers: 4 of the 7 (57.1%) with metastatic rib hot spots and 26 of the 69 (37.7%) with benign rib hot spots.

Extraskeletal Metastases.

Twenty-four of the 93 (25.8%) patients had extraskeletal metastases (19 of 82 [23.2%] with benign and 5 of 11 [45.5%] with malignant rib hot spots) and 69 (74.2%) patients had none (63 of 82 [76.8%] with benign and 6 of 11 [54.5%] with malignant rib hot spots).

Correlation Between the Incidence of Cancer of the Rib Lesions and Clinical Data.

There was no significant correlation between the incidence of cancer of the rib hot spots and clinical data (age, sex, location of rib abnormalities, presence of bone pain, elevation of tumor markers, concordance of the rib lesions with the primary tumor, and occurrence of extraskeletal metastases).

Discussion

Bone scintigraphy is used to detect or to stage progression of metastatic skeletal disease from various primary cancers (3–14). However, the nonspecificity of

| TABLE 1. The Origin of Solitary Rib Lesions in Various Primary Tumors |
|------------------|------------------|------------------|------------------|
| Primary Tumor    | Etiology of Solitary Rib Lesions |              |
|                  | Malignant        | Benign          | Total            |
| Breast           | 3                | 45              | 48              |
| Lung             | 3                | 9               | 12              |
| Nasopharynx      | 2                | 5               | 7               |
| Colon            | 0                | 5               | 5               |
| Kidney           | 0                | 4               | 4               |
| Prostate         | 1                | 2               | 3               |
| Hepatoma         | 2                | 1               | 3               |
| Stomach          | 0                | 2               | 2               |
| Oral             | 0                | 2               | 2               |
| Lymphoma         | 0                | 1               | 1               |
| Bladder          | 0                | 1               | 1               |
| Germ cell tumor  | 0                | 1               | 1               |
| Cholangiocarcinoma | 0            | 1               | 1               |
| Ear squamous cell carcinoma | 0            | 1               | 1               |
| Thyroid          | 0                | 1               | 1               |
| Uterine          | 0                | 1               | 1               |
| Total            | 11               | 82              | 93              |

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Discussion

Bone scintigraphy is used to detect or to stage progression of metastatic skeletal disease from various primary cancers (3–14). However, the nonspecificity of
tracer uptake leads to significant problems in the proper interpretation of a bone scan. Solitary lesions are more difficult to interpret than are multiple lesions (3,4,10). Solitary hot spots in the ribs pose diagnostic problems in patients with proved extraosseous cancers. The differential diagnosis of metastatic or benign scintigraphic bone abnormalities is important not only for providing adequate therapy but also for avoiding unnecessary treatment. One of the aims of this study was to assess the likelihood of a single rib hot spot indicating metastatic bony spread. In the current study, 11.8% (11 of 93 patients) of such solitary rib hot spots were caused by metastases. This finding is consistent with those of Tumeh et al. (4), who reported that 9.8% (4 of 41 patients) of solitary rib lesions in patients with a known primary cancer are due to metastatic disease, substantially less than the 41% (14 of 34 patients) reported by Baxter et al. (8). A comparison of these three studies revealed an important difference in their studied populations. In the study by Tumeh et al. (4), 33 of 41 (80.5%) patients had breast cancer; in the current study, 48 of 93 (51.6%) patients had breast cancer; and in the study by Baxter et al. (8), only 7 of 34 (20.6%) patients had breast cancer. In patients with breast cancer, the rib is an uncommon site of a solitary metastasis (11). It might be presumed that this population difference influenced the incidence of rib metastases. Otherwise, such wide differences are probably attributable to the stage of the tumor when the patients underwent bone scans.

The locations of solitary hot spots in the ribs were documented and evaluated to determine the correlation with the incidence of metastases. In the current study, all 5 costochondral junction lesions were benign, but in the study by Baxter et al. (8), 5 of 14 (36%) costochondral junction lesions were a result of cancer. Our results are consistent with the statement of one nuclear medicine textbook (15) that hot spots near the anterior rib end are almost always traumatic, especially near the costochondral junction. Most of the 11 metastatic lesions were located in the posterior (6 of 11, or 54.5%) and lateral (4 of 11, or 36.4%) aspects of the ribs, which is also where solitary benign rib lesions more frequently appeared. We analyzed the concordance of the rib hot spots with primary cancers. In 63 patients with primary breast, lung, or renal cancers, 83.3% (5 of 6) of the metastatic rib lesions and 75.4% (43 of 57) of the benign rib lesions were concordant with primary cancers. The reason for a high incidence of concordant rib lesions may be that most patients with breast, lung, or renal tumors had operations or radiotherapy on the same side as the primary tumor. That there is no obvious difference in the ratio of concordant lesions between metastatic and benign lesions makes interpretation of solitary rib lesions in bone scintigraphy difficult.

We recorded data on clinical manifestations that might help us interpret solitary rib lesions. We evaluated the relations between these factors and the incidence of metastases. Only 3 of 93 (3.2%) patients had rib lesions with bone pain. One lesion was metastatic and two were benign. The bone pain showed no significant correlation with cancer. Most patients experienced no discomfort because of a solitary rib hot spot. Bone scans can detect tiny lesions before the occurrence of pain, which is often a late manifestation of metastatic bone disease (15). It is also difficult to differentiate the pain caused by metastases from that caused by trauma, inflammation, or other benign causes.

Tumor markers have been used as a warning sign of distant metastases for several years (16). Four of our seven (57.1%) patients with metastatic rib lesions and records of tumor markers had elevated tumor markers, and 37.7% (26 of 69) of the patients with benign rib lesions had elevated tumor markers. The correlation of elevated tumor markers with metastases also proved insignificant. Nicolini et al. (16), however, reported a high diagnostic value for the carcinoembryonic antigen–tissue polypeptide antigen–breast cancer-associated antigen 115 D8/DF3 (CA15.3) tumor marker panel in breast cancer with equivocal bone scintigraphy. The current study, however, included patients with a variety of cancers. Because each primary cancer has different tumor markers, we classified as “positive” the elevation of any tumor markers in the period of follow-up. The heterogeneous population and various tumor markers probably led to different results.

In our study, 5 of 11 (45.5%) patients with malignant rib lesions had extraskeletal metastases: 2 of 3 with breast cancer, 1 of 3 with lung cancer, and 2 of 2 with nasopharyngeal cancer. Of the six without extraskeletal metastases, 1 had breast cancer, 2 had lung cancer, 2 had hepatoma, and 1 had prostate cancer. The relation between extraskeletal metastases and malignant rib lesions proved insignificant in the current study. Because of the small number of cases, further investigation is needed to determine in patients with extraskeletal metastases whether solitary rib hot spots are more likely to be metastatic in some types of cancers, such as breast and nasopharyngeal cancer. Nearly one half of our patients with metastatic rib lesions had no extraskeletal metastases, so bone metastasis in a solitary rib hot spot cannot be ruled out, even without evidence of extraskeletal metastases.

In conclusion, we found that 11.8% of solitary hot spots in the ribs on bone scans of patients with extraskeletal cancer were metastatic in origin. Adding clinical information does not help the clinician differentiate between benign and malignant lesions. The interpretation of solitary rib hot spots thus is not at all simple and
should be undertaken with great care. Patients with extraskeletal cancer who have a single rib hot spot on bone scintigraphy should undergo follow-up bone scans or radiography regularly.

References