Clinical Significance of Isolated Scintigraphic Sternal Lesions in Patients with Breast Cancer

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Isolated scintigraphic sternal lesions are rare. In a retrospective review of the bone scan results of 1,104 patients with breast cancer, 34 individuals (3.1%) presented with this abnormality. Of these foci, 26 (76%) were found to represent metastatic disease. There did not appear to be a relationship with axillary lymph node metastasis, the quadrant involved by primary breast tumor, or selected serum chemistries. These sternal lesions may be associated with regional lymphatic tumor spread rather than hematogenous seeding and therefore could be considered a local recurrence.

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The incidence and significance of isolated sternal metastases have not been well described in the imaging literature because these lesions occur infrequently and are difficult to visualize by conventional radiographic techniques. We noted isolated abnormal tracer uptake in the sternum of a number of patients with breast cancer who were undergoing radionuclide bone imaging. Upon further evaluation, many of these patients had documented sternal metastatic lesions. We therefore undertook a retrospective analysis of the bone scan results in patients with breast cancer to assess the incidence, correlative results, and clinical significance of these isolated sternal findings.

MATERIALS AND METHODS

The radionuclide bone images from 1982–1985 of 1,104 consecutive breast cancer patients formed the basis for our analysis. Imaging was performed 3–4 hr following the intravenous administration of 20 mCi technetium-99m (^{99m}Tc) methylene diphosphonate (DuPont Company, Diagnostic Imaging Division, No. Billerica, MA). Static 500,000 count images of the axial skeleton were obtained using a 37 photomultiplier tube, large field-of-view gamma camera (Siemens Medical Systems, Inc., Iselin, NJ) fitted with a 39,500 parallel hole, hexagonal array, high-resolution collimator.

Any asymmetric focal or asymmetric diffuse increase in tracer uptake seen in the sternum relative to the remainder of the skeletal system was considered to be an abnormal finding (Fig. 1). All patients with abnormal images had conventional lateral and oblique sternal radiographs performed at the time of radionuclide bone imaging that were interpreted in conjunction with the scintigraphic study.

Additional radiographic studies included linear tomography of the sternum (five patients), computed tomography (CT) of the thorax (14 patients) and radionuclide internal mammary lymphoscintigraphy (five patients). Lymphoscintigraphy was performed by obtaining anterior 100,000 count views of the thorax 3 hr following posterior rectus sheath injection of 1.0 mCi [^{99m}Tc]antimony trisulfide colloid (Cadema Medical Products, Middletown, NJ) (*1*). Internal mammary lymphadenopathy by CT scan was considered present if a lymph node larger than 6 mm was visualized (*2*). Clinical follow-up was obtained over 6 to 48 mo (median 20 mo).

RESULTS

Etiology

A total of 34 solitary sternal abnormalities were identified in the 1,104 patients with breast cancer (3.1%). Twenty-six of the 34 lesions (76%) were a result of metastatic disease confirmed by one or more diagnostic radiologic tests.

Two lesions were attributed to degenerative disease as manifested on plain radiographs and six lesions remain of unknown etiology since no additional radiographic abnormality has been documented and the patients have remained clinically asymptomatic over the period of follow-up.

Location of Sternal Metastases

Of the 26 malignant lesions, ten (38%) were located in the manubrium, eight (31%) in the manubriosternal

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FIGURE 1
Routine bone scan performed in asymptomatic patient with left breast cancer shows a solitary focus of increased uptake at the left sternal border with no radiographic abnormality. Follow-up radiograph at 6 mo showed a lytic lesion.

junction, six (23%) in the body of the sternum and two (8%) in the xyphoid process (Table 1).

Documentation of Sternal Findings

Ten of 26 patients with sternal abnormalities on bone scan had documented lytic lesions on conventional radiographs at the time of initial examination. Of the 16 patients with negative plain radiographs, three patients were studied further with linear tomography and five patients with CT scans. One of three demonstrated a sternal metastasis by linear tomography and four of five by CT scan. One patient had sternal metastasis identified by both imaging modalities.

On follow-up studies over 6–48 mo, nine of the remaining 12 patients manifested a metastatic lesion on plain radiograph, the remaining three patients by linear tomography and/or CT scan.

Relationship of Symptoms and Signs

Of the 20 patients with sternal metastases for whom clinical information was available, 15 had sternal pain and five were asymptomatic at the time of initial bone imaging findings. All 20 of these patients presented with normal serum values for alkaline phosphatase, calcium, and carcinoembryonic antigen.

TABLE 1
Site of Sternal Involvement

Site of uptake	Number of patients		
	Malignant	Benign	Unknown
Manubrium	10	0	2
Manubriosternal Junction	8	2	3
Body	6	0	0
Xyphoid	2	0	1

Relationship to Internal Mammary Lymph Nodes

For purposes of radiation therapy portal planning, radionuclide lymphoscintigraphy (RNLS) of the internal mammary nodes (IMN) had been performed in five patients before any evidence of sternal abnormality was seen on bone scan. All five patients showed an abnormal scintigraphic pattern of radiocolloid uptake interpreted as compatible with early tumor involvement of the internal mammary lymphatic chain (Fig. 2A, 2B).

Fourteen patients, including the five who had RNLS, underwent chest CT. Of these, ten (71%), including four of five RNLS patients, demonstrated enlarged internal mammary lymph nodes (Fig. 2C).

Relationship to Axillary Lymph Node Metastasis

The presence of metastatic involvement of the axillary lymph nodes at the time of initial staging did not appear to show a relationship to subsequent sternal metastases. All 26 patients with sternal metastasis underwent axillary sampling at the time of initial staging; only nine (35%) evidenced tumor-positive lymph nodes. Among the 11 patients with enlarged IMN as demonstrated by CT and/or abnormal RNLS, only two had positive axillary nodes.

Relationship to Site of Primary Breast Lesion

There did not appear to be a relationship between the quadrant involved by the primary breast tumor and subsequent sternal involvement. Although all of the 26 metastatic lesions occurred on the same side of the sternum as did the primary breast tumor, the tumor was located in the lateral portion of the breast in 16 patients (62%) and in the medial portion in the remaining ten (38%). The small sample size precluded a more rigorous analysis.

Relationsip to Development of Other Metastatic Sites

Fourteen of the 26 patients with solitary sternal metastases developed other metastatic sites involving the skeleton (eight patients), lungs (seven patients), and viscera (two patients), during the follow-up period (Table 2).

DISCUSSION

The normal sternum on bone scan will usually display a linear accumulation of tracer at the cortical margin that corresponds to the CT scan appearance (*3*). The presence of a well-defined region of increased uptake in 36% of radionuclide bone images at the manubriosternal junction is also regarded as a normal finding (*4*), the intensity of this uptake probably inversely related to the degree of fusion (*5*).

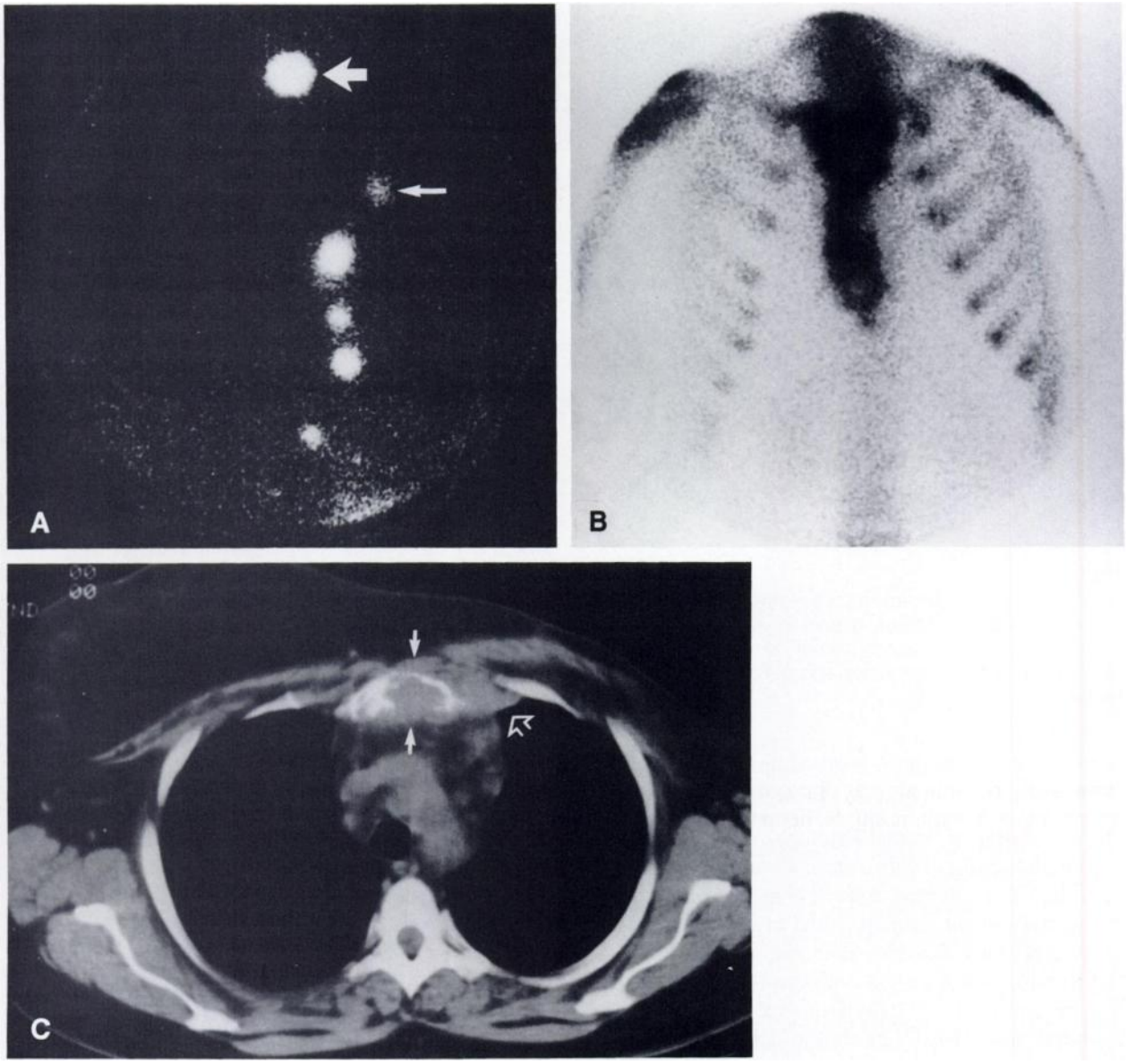

FIGURE 2
A: Internal mammary lymphoscintiscan in patient with left breast carcinoma performed for radiation therapy planning, shows lymphatic obstruction cephalad to node at third rib (small arrow). Sternal notch marker is denoted by large arrow. B: Bone scan performed 2 yr later to screen for skeletal metastases shows mixed pattern of diffuse increased sternal uptake with focal areas of decreased uptake involving predominantly left border. C: CT scan performed at the time of bone scan shows lytic sternal lesion (closed arrows) and internal mammary lymphadenopathy (open arrow).

We noted that one fourth of our patients in whom clinical data were available were asymptomatic at the time of a positive scintigraphic sternal finding. This number is consistent with that reported in the literature (*6*) and underscores the utility of bone imaging in the asymptomatic patient.

Fifteen percent of all patients with an underlying malignant process who are undergoing scintigraphic bone evaluation have been shown to have a solitary abnormal focus (*7,8*). Of importance, more than half of these solitary scan findings are associated with a malignant etiology (*9*). However, this latter percentage appears to depend on the site of the focus. For instance, abnormalities in a single rib in patients with extraosseous primary malignancies were due to a metastatic etiology in 10 to 46% of cases (*10,11*).

In contrast, although only 3.1% of scintigrams of our patients with breast carcinoma demonstrated an isolated sternal abnormality, 76% were due to a malignant etiology. Therefore, even though this finding is rare, it carried a high probability of a metastatic etiology in this patient population.

An intriguing potential relationship between the internal mammary lymphatic chain and isolated sternal lesions evolved during this investigation. Early abnormal findings on RNLS were often associated with later CT documentation of enlarged internal mammary nodes (four of five patients) and subsequent sternal metastasis. Also, 10 of 14 patients (71%) with solitary sternal metastases who underwent CT examination demonstrated internal mammary lymph node enlargement. These associations would suggest the potential for the presence of a local metastatic pathway from the primary breast tumor to the sternum via the internal mammary chain rather than sternal involvement by a hematogenous route.

With respect to the location of the nodal abnormalities, Meyer and Munzenrider (*2*), in evaluating the CT scan appearance of internal mammary lymphadenopathy in 18 patients, found that the majority of these enlarged nodes presented in the first and second intercostal spaces at the level of the manubrium and proximal sternal body. Kaplan et al. (*12*) in an anatomic review of normal internal mammary lymphoscintiscans in 167 breast cancer patients showed that 72% of 768 nodes were indeed located about the first and third ribs. These data and the hypothesis of a local lymphatic pathway could explain why 69% of our patients presented with lesions involving the manubrium or the manubriosternal junction as opposed to a general cancer population with multiple hematogenous skeletal metastases, where sternal lesions were reported to be located in the sternal body in 95% (*13*) and 100% (*14*) of cases.

The potential for metastatic tumor cells to migrate from any quadrant of the breast to the internal mammary lymphatics has been well documented surgically (*15*). Vendrell-Torne et al. (*16*) scintigraphically documented this finding by demonstrating drainage of intramammary radiocolloid to the internal mammary lymph nodes from all breast quandrants as well as from the central area of the breast. Drainage of the internal mammary lymphatics cephalad to the subclavian veins can explain additional sites of nonosseous metastatic disease involving primarily the lungs.

CONCLUSION

Although isolated sternal abnormalities are uncommon in patients with breast cancer, a high percentage of these lesions are due to a malignant etiology. Any such scintigraphic finding should raise a high suspicion of metastases and, in the appropriate clinical circumstance, be confirmed by further radiographic studies or biopsy. If plain radiographs are normal, CT scanning or linear tomography of the sternum should be performed with special attention to the level of the radionuclide abnormality.

TABLE 2
Association of Sternal Metastases to Involvement of Other Sites

Associated metastatic sites	Number of patients
Skeletal	7
Pulmonary	4
Pulmonary and skeletal	1
Pulmonary and visceral	2

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