Ultrasonographic Detection and Guided Biopsy of Thoracic Osteolysis*

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Eighty-six osteolytic lesions of the rib cage were examined by means of conventional radiography and ultrasonography. The ultrasonographic criteria of osteolysis are described. Only 1 rib metastasis was missed by ultrasonography while 13 lesions were not detected by x-ray film. Of 63 ultrasonographically guided biopsies, 62 resulted in the final diagnosis; complications were not observed. The results recommend ultrasonographic examination combined with guided biopsy as the first diagnostic step, if a metastasis of the rib cage is suspected after physical examination or after a pathologic bone scan. (Chest 1993; 104:1003-05)

The bone scan is admittedly the most sensitive screening device for bone metastasis, but the results remain ambiguous. Therefore, the diagnosis usually has to be confirmed by radiographs and often by definitive tissue diagnosis.

Especially in rib metastasis, guided biopsy and also surgical exploration present problems of localization unless the lesion is palpable. Thus, more expensive imaging procedures like nuclear scan-guided biopsy were introduced. 1-3

During ultrasonography of the thoracic wall in a patient with lung cancer, we accidentally noticed signs of an osteolytic rib metastasis. Since that time, we have tried to define the typical ultrasonographic image of osteolysis and to estimate the validity of ultrasonography and conventional x-ray films detecting malignant thoracic osteolysis.

MATERIALS AND METHODS

Between 1983 and 1991, we examined 86 patients showing osteolytic lesions in the ribs (77) and the sternum (9). Ultrasonography was performed by means of the usual linear array scanners with 3.5 Mhz (Philips SDR 2000 or Aloka SD 630). Conventional radiographs included standard thoracic x-ray films, fluoroscopy, and if necessary, computed tomography.

Cytologic biopsies were performed under ultrasonographic guidance for the following reasons: if definitive tissue diagnosis was necessary for staging the known disease; or if an unknown primary tumor had to be elucidated, especially if the suspected region seemed to be normal under radiologic examination.

Biopsies were performed with usual one-way syringes and needles as used for intramuscular or intravenous injection, after local anesthesia with 1 percent solution of procaine. The specimens were immediately stained and air-fixed. Repeated biopsy specimens were taken if the Diff-Quik preparation showed no usable material, ie, tissue that was necrotic or too bloody.

RESULTS

Ultrasonographic Signs of Osteolysis

Healthy bone cannot be examined sufficiently by usual ultrasonography because of the total sound reflection resulting in a sound shadow behind the leading edge. This total reflection changes if the metastatic part of the bone loses calcium and thus achieves conductivity.

If the loss of calcium is total, the osteolytic metas-

![Figure 1. Plasmocytoma of the seventh rib. Left. X-ray film shows an osteolytic fracture. Right. Ultrasonography shows section along the rib without sonic shadow behind the osteolysis.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21676/ on 06/27/2017)
Metastasis appears as an echo-poor area of mostly increased volume, and the sound shadow disappears, as demonstrated in Figure 1.

Partial destruction of a rib is shown in Figure 2. The sound shadow is only slightly diminished, but the improvement of sound conductivity is clearly demonstrated by the intact white line representing the pleural surface. Behind the normal ribs, this line is broken by the sound shadow.

In an early stage of osteolysis, the change of conductivity is too small to detect which part of the bone is diseased. But in those cases, often a slight swelling of the surrounding tissue exists, probably due to periosteal edema. This phenomenon is not recognizable by x-ray film. Thus, the scintigraphic hot spot in Figure 3 was not explained by conventional computed tomography, but clearly detected by ultrasonography and confirmed as a metastatic adenocarcinoma by cytologic biopsy.

**Ultrasonographically Guided Biopsy**

Sixty-three cytologic biopsies were performed under ultrasonographic guidance, localized to the ribs in 57 and to the sternum in 6 cases. The results are listed in Table 1.

Only one biopsy was not diagnostic, due to insufficient technique rather than to the disease itself. It concerns a hemangioendothelioma, which is known to be barely confirmed by a small cytologic sample. In the remaining 62 cases, the biopsy was definitive or consistent with the final diagnosis.

There were no complications, especially no pneumothorax or abnormal bleeding.

**Ultrasonography vs Radiography in the Discerning of Osteolysis**

Eighty-six osteolytic lesions of the thoracic skeleton (ribs, 77; sternum, 9) were examined by both techniques, after the localization was suspected by physical examination, thoracic x-ray film, or scintigraphy.

Only one rib metastasis recognizable by x-ray film was missed by ultrasonography because it was partially hidden behind the scapula. Moreover, this lesion seemed to be osteoplastic rather than osteolytic.
Table 1—Cytologic Results of Ultrasonographically Guided Bone Biopsies

<table>
<thead>
<tr>
<th>Metastasis of Bone</th>
<th>No.</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasmacytoma</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Lung cancer</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Renal</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Eosinophilic granuloma</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Prostate</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Benign cyst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breast</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hyperparathyroidism</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gastric</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Indistinct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esophagus</td>
<td>1</td>
<td>Total 63</td>
</tr>
<tr>
<td>Melanoma</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Therefore, an increase of sonic conductivity could not be expected. In comparison, seven of the rib and six of the sternum metastases were not seen by x-ray film but clearly detected by ultrasonography; an example is shown in Figure 3.

The sternum, in particular, is poorly visible on x-ray films or fluoroscopy, as happened in the case of Figure 4. Probably this extensive osteolysis of the manubrium would have been recognizable by computed tomography, but we could refrain from using this intricate procedure after obtaining proof of diagnosis by ultrasonography and by guided biopsy.

An ultrasonographic exploration of the chest wall also was made even when the physical examination only resulted in localized pain. In this way, one metastasis was found and confirmed by biopsy. It was not detected by x-ray film or by scintigraphy.

**Discussion**

Hot spots in the bone scan usually need confirmation by x-ray examination or by biopsy before being diagnosed as malignant. In this situation, ultrasound seemed to be unimportant; probably the bad imaging results on healthy bones have led to this poor estimation. However, this verdict is not justified in the case of metastatic bone lesions, which can by all means be determined by sonography.1,4

Although radiography is without any doubt the leading diagnostic procedure for the extremities, ultrasonography offers definite advantages in examination of the thoracic skeleton. Except for the vertebrae and a small region behind the upper scapula, the whole rib cage and the sternum can be examined unhindered by ultrasonography, where radiography is handicapped by the superposed lung structure, through which a small bony lesion can be missed. These disadvantages can be compensated for largely by tomography; but it often remains impossible to perform a biopsy under fluoroscopic guidance. The ventral parts of the ribs and the sternum, in particular, are poorly visible during fluoroscopy, as are the processes of the spine, but these regions are especially easy to reach by ultrasonography.

Our investigation has shown that ultrasonographically guided biopsy performed by means of very inexpensive equipment (one-way syringe and cannula) yields a very high diagnostic rate at least in metastatic cancer and plasmacytoma, in which a cytologic specimen usually is sufficient for diagnostic proof. In malignant lymphoma and primary bone malignancies, the necessary histologic specimens also can be taken under ultrasonographic guidance. Thus, the use of more costly procedures, such as nuclear scan-guided biopsy,1,3 could be reduced to the rare cases of ultrasonographically invisible lesions.

**Conclusion**

Osteolytic lesions of the thoracic skeleton can be identified using ultrasonography as well as or better than by radiography. The diagnostic success of ultrasonographically guided biopsy is very high, although the technical requirement is small. Therefore, we recommend ultrasonography and, if necessary, guided biopsy as the first step in the diagnostic procedure, where physical examination or bone scan suggest thoracic bone metastasis.

**References**

2. Prasad R, Olson WH. Bone marking for biopsy using radionuclide bone imaging. Cancer 1987; 60:2205-07