The value of ultrasonography and UGAB for diagnosing chest wall tumors was investigated in 21 patients of whom 13 had metastatic and eight benign disease. Chest wall tumors showed a hypoechoic mass with tapered edges. The margin between the tumor and lung was curved and smooth in all cases. Movement of the tumor during breathing was synchronized with that of the chest wall. We believe that the ultrasonography is of value in identifying tumors that are localized to the chest wall by examination of their margin and movement with respiration, in addition to their shape. Using UGAB, we were able to diagnose correctly all eight metastatic tumors and two of four benign tumors. UGAB is a safe and simple procedure for diagnosing chest wall tumors. (Chest 1988; 94:1271-73)

**UGAB = ultrasonically guided aspiration biopsy**

**Material and Methods**

Twenty-one patients with chest wall tumors proved histologically or cytologically were included in this study. Thirteen of the tumors were metastases, and eight were benign. The diagnosis was confirmed histologically in three cases of metastatic tumors at autopsy and in all eight benign tumors at the time of operation. Cytologic examination results confirmed the diagnosis in the remaining ten malignancies, using specimens obtained by UGAB. There were 14 men and seven women, with a mean age of 64 years (range, 17 to 73 years). Included were 13 cases of cancer metastatic to the chest wall, three lipomas, three neurinomas, one chondroma, and one desmoid. Among the 13 metastases to the chest wall, six were from lung cancers, two were from hepatocellular carcinomas, and there was one each from an osteosarcoma, malignant lymphoma, malignant melanoma, breast cancer, and renal cell carcinoma.

**FIGURE 1. Ultrasoundogram of a normal chest wall.** Chest wall appears as a layered structure. Lung surface, or pleural line (arrows), is hyperechoic.
hyperechoic curved line, but its inner structures are obscured by air. Using ultrasonography, we evaluated the shape of the tumor, its internal pattern of echoes, the margin between the tumor and lung, and the movement of the tumor during respiration.

UGAB was performed in 13 cases: nine metastatic tumors and four benign tumors. To obtain the biopsy specimen, we used a linear electronic array scanner provided with a central channel for introduction of the needle (4 MHz) (model GCB-306M, Toshiba). We used an 18- to 21-gauge aspiration biopsy needle made of steel and consisting of an inner stylet and an outer sheath. The needle was 20 cm in length and had a bevelled tip.

RESULTS

In evaluating the shape of chest wall tumors, tapered edges were demonstrated in 17 cases, which radiologically indicates an extrapulmonary lesion, and the margin between the tumor and the lung was curved

and smooth (Fig 2). In two cases (lipoma and malignant lymphoma), the tumor was well localized within the chest wall and did not protrude beyond either the inner or outer surface of the chest wall (Fig 3). Tapered edges were absent in such cases. We were able to evaluate accurately the extent of the tumor within the chest wall because of the excellent discrimination among many types of soft tissues. One chondroma and one metastatic lung cancer did not display typical tapered edges (Fig 4). In these cases, we were unable to distinguish the chest wall from intrapulmonary tumors by shape alone. The ultrasonographic pattern of internal echoes was hypoechoic and showed a solid pattern in all of 21 tumors.

The pleura can be visualized clearly by ultrasonography, but not routinely by other diagnostic modalities. Therefore, ultrasonography is of value in localizing the tumor, if the relationship between the tumor and the pleura can be established. In 19 cases, tumors grew mainly toward the lung, and the pleural line (the margin) between the tumor and lung was curved and continuous. In two cases of tumors within the chest wall, the pleural line was straight, continuous, and intact. In the case of the subpleural lipoma, we identified the visceral and parietal pleura separately, and we were able to localize the tumor within the pleural space prior to surgery (Fig 5). The 7.5-MHz scanner was used in seven cases, and the internal structure of the tumor and its relationship to the pleura was visualized more clearly (Fig 5). We were able to analyze the internal echo pattern in detail to a depth of about 3 cm.

We also evaluated the movement of the tumor during

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We also evaluated the movement of the tumor during
respiration. If the tumor abutted the chest wall but was located at the lung parenchyma, its movement was synchronous with the lung, unless there was invasion or adhesion to the chest wall. If the tumor was located within the chest wall, its movement was synchronous with the chest wall. Therefore, evaluation of respiratory movement is a useful adjunct in establishing tumor localization. In this study, the respiratory movement of the tumor was synchronized with the chest wall movement in 20 cases. In the case of the subpleural lipoma, in which the greater part of the tumor was in the pleural space, we observed a change in the shape of the tumor with respiration, and the movement of the tumor during respiration was not synchronized with the lung or chest wall. We found observation of tumor movement particularly useful in correctly identifying the location of the two chest wall tumors that did not demonstrate the tapered edges typical of these lesions (Fig 4).

The extent of the tumor is visualized so clearly by UGAB that it is a safe and simple procedure for diagnosing chest wall tumors. We performed UGAB in 13 cases, including nine metastatic tumors and four benign tumors. In all cases of metastases, malignant cells were obtained, and a definitive cytologic diagnosis was established; in two of four benign tumors as well, the cytologic diagnosis was definite. Clusters of spindle-type cells were aspirated from a neurinoma, which were highly suggestive of this lesion. In the chondroma, cartilaginous tissue without atypism was aspirated, and the cytologic diagnosis was chondroma. The lipoma and desmoid yielded no cellular components on aspiration. No complications of UGAB occurred, and pneumothorax was not encountered.

**DISCUSSION**

Tumors of the chest wall may originate in the bony thorax or in deeper tissues. For diagnostic evaluation, it is important to determine tumor localization in the chest wall. However, with conventional radiology, it is often difficult to differentiate tumors of the chest wall from invasion of the chest wall by lung cancer and pleural lesions such as loculations of pleural fluid. CT is used widely for evaluating tumors of the chest wall. CT, in this reference, is used mainly to determine the tumor shape. It cannot localize these lesions with certainty, because it cannot clearly discriminate the chest wall and pleura from the tumor itself. Stated somewhat simply, tapered edges are the only means of localizing the tumor by CT.

In this study, ultrasonography detected tumors in all 21 cases studied. We were able to visualize the soft tissues of the chest wall and pleura clearly and evaluate

![FIGURE 5A. Ultrasonogram (5 MHz) of subpleural lipoma demonstrating separately visualization of visceral and parietal pleura (arrows). B. The pleura (arrows) and tumor are visualized more clearly by 7.5-MHz scanner.](image)

![FIGURE 6. Ultrasonogram of chest wall invaded by lung cancer. Disruption of pleura (arrows) is shown, and tumor has no tapered edges.](image)
Ultrasound in Diagnosing Chest Wall Tumors (Saito, Kobayashi, Kitamura)

their movement during respiration. Chest wall tumors typically demonstrated tapered edges, and the margin between the tumor and lung was curved and smooth. Movement of the tumor during breathing was synchronized with that of the chest wall. In contrast, when the chest wall has been invaded by lung cancer, the margin between the tumor and lung is irregular. Tumor echoes extend to the chest wall through the pleura, and disruption of the pleura is seen (Fig 6). In such cases, no movement of the tumor occurs during respiration. These ultrasonographic findings allow differentiation of chest wall tumors from invasion of the chest wall by lung cancer.2,12

It may be difficult to distinguish chest wall tumors from lesions in the pleural space, such as loculations of pleural fluid, since these shapes are similar radiologically.13 On ultrasonograms, internal echoes of chest wall tumors showed a solid pattern and that of loculated pleural fluid usually showed a cystic pattern (Fig 7).14,15 Further, we can often visualize the visceral and parietal pleura separately.3 Ultrasonographic localization of the tumor or lesion can be made with certainty under such conditions.

Demonstrating tumor invasion into the lung is important for the choice of therapy and also in assessing the prognosis of the patient with a chest wall tumor.6,7 Conversely, Sugama and coworkers4 reported that the accuracy of ultrasonography was excellent for evaluating lung cancer invasion to the chest wall. Ultraso-

nography is reliable, because we can identify the pleura and visualize the movement of the tumor with respiration in real time. We likewise think that ultrasonography will be useful for evaluating tumor invasion into the lung by chest wall tumors, although no such cases were included in this series. We occasionally used the 7.5-MHz scanner with a water path and visualized the pleura and tumor to a depth of about 3 cm more clearly. We think that the 7.5-MHz scanner should be utilized more, since it permits more detailed ultrasonographic imaging.

We also have performed UGAB to evaluating mediastinal tumors and lung cancer.4,16 UGAB clearly detects the extent of chest wall tumors and the position of the needle tip.4 Thus, UGAB is a simple and safe diagnostic technique for these lesions. In our study, a cytologic diagnosis of metastatic tumor was achieved easily in all cases, while the diagnosis of benign tumor was more difficult.17,18 Percutaneous needle biopsy using a Tru-cut needle (Travenol laboratories) biopsy should be performed, if possible, when aspiration is unsuccessful in producing a specimen. We encountered no complication with this method. Clearly, UGAB is a useful procedure for diagnosing chest wall tumors.

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Figure 7. Ultrasonogram of loculated pleural fluid reveals an echo-free space with tapered edges (arrow).
Chest Wall and Lung Surface Viewing with Ultrasound

Jason Birnholz, M.D.*

The preceding article, by Saito and colleagues, represents the continued interest of this group in applying ultrasonic imaging to the diagnosis of thoracic wall abnormalities. We have tended to use CT and MRI in this country without thorough investigation of all methods. These authors illustrate that it is the unique ability of ultrasound for defining and characterizing soft tissues that recommend its use for studying the chest wall, not its availability, safety, or economy.

There are some obvious differences in image quality of the illustrations in this article. The 7.5 MHz imaging capability was presumably acquired late in their investigation, yielding views with vastly lower noise content and conveying underlying tissue histology more exactly than do the lower frequency images of the earlier part of the study. These image transitions are part of the process of equipment advances that prompt clinical reappraisal of the role of ultrasound in a range of diagnostic uses. The value of ultrasound depends upon the operator and the instrumentation: expert use of optimal equipment can be extraordinarily informative in diagnostic practice.

For some years, development of academic and commercial instruments has centered upon multielement array transducers (rather than the original single element design) with sophisticated, high speed (digital) computer methods for electronic beam forming and steering, signal processing, and display conditioning. One consequence of these advances has been enhanced portrayal of superficial structures, such as the chest wall, pleura, and lung surface. Early on, ultrasound use in the chest was limited to determining the depth of the lung surface for radiation therapy purposes, while we can now evaluate the lung surface for subtle signs of interstitial disease (Fig 1) or neoplasm. There is, however, the continued limitation that sampling the pleura and lung surface are restricted to intercostal portals. Bone is impenetrable in adults,

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FIGURE 1. The lung surface (arrows) is a highly reflective boundary. A (top) shows a smooth (normal) border (scale markers are at 5 mm intervals). There are minimal surface irregularities in the lung surface of an asymptomatic urban dweller in B (center), but the border is obviously coarsened and scarred in a patient with interstitial lung disease due to scleroderma in C (lower).