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ORIGINAL ARTICLE

Clinical utility of image-guided chest wall mass biopsy: results in 28 patients

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Abstract

The purpose of our study was to determine the clinical usefulness of percutaneous image-guided biopsy of chest wall masses. A retrospective study of 28 patients who underwent image-guided biopsy of chest wall masses from 2005 to 2007 was performed. In 19 (68%) patients, the mass was detected as part of a staging evaluation in patients with known malignancy; 9 (32%) patients had no known malignancy. Biopsy results were classified as diagnostic (malignant or benign) or non-diagnostic (atypical and insufficient). Sensitivity, specificity and negative predictive value were calculated for all patients, and the Fisher–Freeman–Halton exact test was used to determine if test characteristics varied in patients with and without a history of cancer, masses smaller and greater than 5 cm, or according to needle size. The overall diagnostic rate was 71%. Of these, there were 20 true-positives, 3 true-negatives, 5 false-negatives and no false-positive results (sensitivity 80% (20/25), specificity 100% (3/3) and negative predictive value 37.5% (3/8)). There were no differences between patients with and without cancer. Among 19 patients with known cancer, 10 had metastatic disease from their known primary. Biopsy test characteristics did not differ with respect to mass or needle size. Minor complications were seen in 7% of patients. Image-guided chest wall mass biopsy is a sensitive and specific procedure, which is clinically important in the care of patients both with and without a known primary cancer.

Keywords: *Chest wall masses; biopsy; oncology; malignancy.*

Introduction

Tumors of the chest wall are uncommon and include benign and malignant diagnoses[1,2] which can be further classified into those arising from bony structures and those of soft tissue origin. The clinical findings and the radiological appearance of soft tissue chest wall tumors has been previously reported in the literature[3]; however, the appearance does not necessarily correlate with a specific diagnosis. Since critical management often depends on the distinction between a benign and a malignant lesion, percutaneous biopsy is often needed.

The aim of our study was to determine the clinical usefulness of percutaneous image-guided biopsy of chest wall masses and demonstrate our experience with image-guided chest wall mass biopsies, focusing on the utility of the procedure in clinical practice and assessing the effect of patient history, mass size, and needle size on biopsy results.

Materials and methods

Patients and biopsy procedures

Retrospective analysis of patients who underwent image-guided chest wall mass biopsies over a 2-year period (from July 2005 to June 2007) was performed, after obtaining Institutional Review Board approval. Our study population consisted of 28 patients (15 women, 13 men; mean age 62.4 years; age range 27–88 years).

Nineteen patients who presented for chest wall mass biopsies had known malignancies, including breast carcinoma ($n = 5$), lung carcinoma ($n = 5$), lymphoma ($n = 2$) and one case each of melanoma, soft tissue

sarcoma, neuroblastoma, esophageal carcinoma, germ cell tumor and prostate and vulvar carcinoma. Nine patients presented with chest wall masses without a known malignancy and had chest pain, fever, soft tissue bulge or erythema.

Chest wall mass sizes were determined by measuring the maximum craniocaudal or transverse dimension of the mass (rounded to the nearest 5 mm) in all patients. Sizes ranged from 2 to 13 cm. The average size was 5.2 cm. Computed tomography (CT) guidance was used in 23 biopsies, and ultrasound guidance was used in 5 biopsies. The decision to perform the biopsy under CT or ultrasound guidance was based on physician preference and discretion. For large masses promoting chest wall bulge ultrasound was preferred over CT guidance. For small masses adjacent to normal lung parenchyma, CT was used as the modality of choice.

Needle gauge data and the total number of passes for each procedure were available in all biopsies. Twenty-four biopsies used only 20 or 22-gauge (fine needles, Westcott™ needle). During 4 biopsies, an 18-gauge (large needle) was used in addition to fine needles. Fine-needle aspiration (FNA) was preferred to sample small lesions and lesions adjacent to major vessels or adjacent to the lung, or when there was an imminent risk of pneumothorax. The total number of FNA samples was determined by the adequacy assessment by the on site cytotechnologist.

Pathologic results

Pathologic results were grouped into three major categories: benign, malignant and non-diagnostic. A benign diagnosis included specimens interpreted as a specific benign entity, such as desmoid fibromatosis, schwannoma or specimens containing material suggesting a specific infectious/inflammatory process. Malignant diagnosis consisted of specimens containing malignant cells. Non-diagnostic results encompassed unsatisfactory specimens and atypical cells when atypia was seen in the specimen, suggestive but not definitive of a benign process. For the purposes of the analysis, the first two categories were considered diagnostic and the last category was non-diagnostic.

When malignancy was obtained it was considered a true-positive. All patients in whom biopsy results were defined as benign, atypical or non-diagnostic were followed; the biopsy result was defined as true-negative if surgery confirmed a benign or atypical result of the biopsy, or absence of growth on CT, or clinical follow-up for 12 months or more after the biopsy. The biopsy result was considered false-negative if, after a benign or non-diagnostic FNA, a surgical biopsy resulted in malignant diagnosis.

Sensitivity and negative predictive value were calculated, classifying malignant and benign results as diagnostic and the other results as non-diagnostic. Sensitivity and negative predictive value were calculated for the overall group and for the following subgroups: patients with cancer and patients without cancer, patients with masses smaller or larger than 5 cm and biopsy specimens with FNA alone or with FNA in addition to large needles. The significance of differences of the values among these groups was assessed with the Fisher exact test. Among patients in whom diagnostic results were obtained, the test characteristics of each subgroup were compared with those of the overall group and of its counterpart.

Results

Among the 28 biopsies from 28 patients, a diagnostic result (malignant or benign) was obtained in 20 patients (72%) including adenocarcinoma ($n = 8$), lymphoma ($n = 3$) (Fig. 1), squamous cell carcinoma ($n = 3$), focal gram-positive infection with associated granulation tissue consistent with chronic inflammatory process ($n = 2$) and one case each of dendritic cell sarcoma, schwannoma, desmoid tumor and melanoma.

A specific benign result (desmoid fibromatosis) was rendered in a patient with previous breast cancer, who presented with an anterior chest wall mass. A positron emission tomography/CT scan demonstrated mild tracer uptake, raising concern for a radiation-induced neoplasm or metastatic disease. Percutaneous image-guided biopsy showed desmoid fibromatosis of the chest wall. Another patient with a specific benign result had a mass in the posterior chest wall without any specific symptoms. The lesion was well defined without bone destruction. FNA was performed and the result was consistent with schwannoma.

Two patients had evidence of an infectious process and had cultures positive for gram-positive cocci. Follow-up imaging demonstrated resolution of the chest wall infection after anti-inflammatory and antibiotic therapy.

Non-diagnostic results were obtained in 8 (28%) patients; of these, 3 were atypical cells and proved malignant on surgical biopsy. One patient had history of non-small cell lung cancer (NSCLC) and presented with a chest wall mass. Surgical resection was performed and showed metastatic NSCLC. A second patient, who had an FNA consistent with atypical cells, underwent surgical biopsy of a left anterior chest wall mass, showing a malignant peripheral nerve sheath tumor. A third patient showed metastatic mixed germ cell tumor comprised of yolk sac tumor and embryonal carcinomas at surgical biopsy of a left anterior chest wall mass.

Five of the non-diagnostic results were interpreted as insufficient cells. In one patient, findings were consistent with inflammatory process in the absence of malignancy on surgical biopsy. In two cases, the results were consistent with fibroadipose tissue and granulation tissue on subsequent surgical biopsy. Two cases proved to be malignant, both after surgical biopsy, which revealed, low-grade spindle cell sarcoma and metastatic squamous

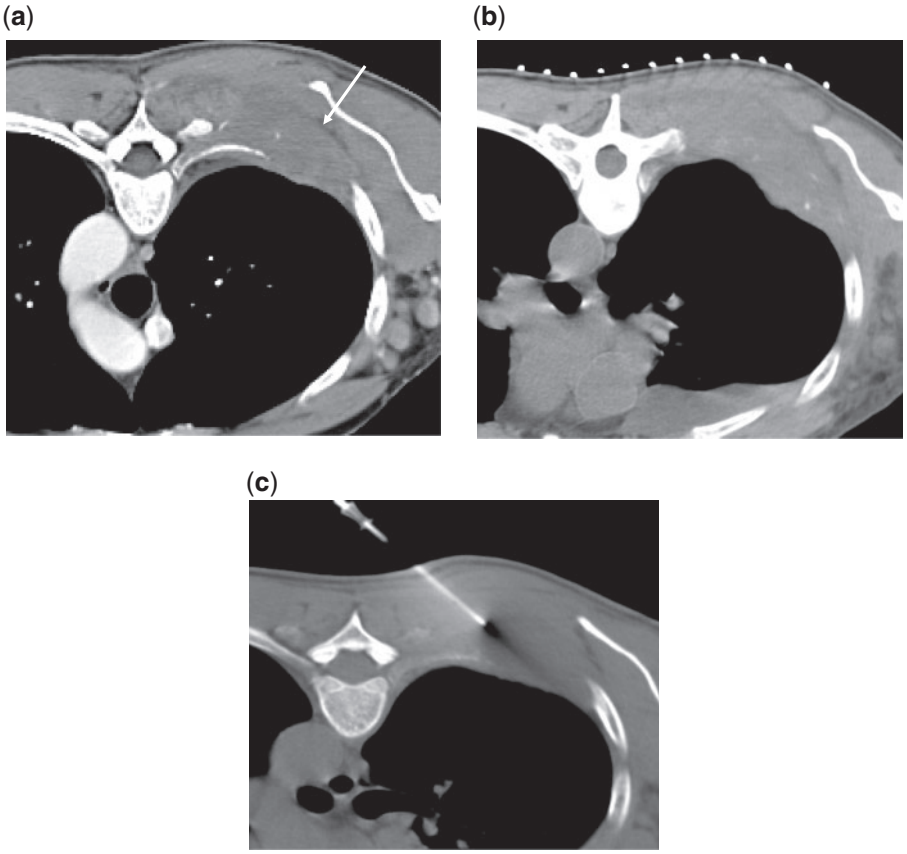

Figure 1 **A 54-year-old woman with a history of non-Hodgkin lymphoma who presented with a chest wall mass during routine screening. (a,b) Contrast-enhanced CT scan reveals infiltrative enhancing soft-tissue mass in the right posterior chest wall (arrow). (c) Under CT guidance, 18-gauge × 9 cm biopsy needle (arrow) was inserted into mass; cytopathology revealed non-Hodgkin lymphoma, large B cell type.**

Table 1 Summary of 28 patients who underwent chest wall biopsy

Number of patients	28
Mass size (cm)	
Range	2–13
Average	5.2
Biopsy needle gauge	
Fine (20 or 22 g)	24
Fine and Large	4
Guidance (*n*)	
CT spiral	7
CT real-time fluoro	16
Ultrasound	5
Patient population (*n*)	
Oncologic	19
Non-oncologic	9

cell carcinoma from primary esophageal cancer. The characteristics of all 28 patients who underwent chest wall biopsy are presented in Tables 1 and 2.

Among 19 patients with known cancer, 10 (53%) had metastatic disease from their known primary cancer (Fig. 2). Among 28 patients undergoing chest wall mass biopsies, there were 20 true-positives, 3 true-negatives, and 5 false-negatives. Percutaneous image-guided biopsy of chest wall masses, therefore, had an overall sensitivity of 80% (20/25) and negative predictive value of 37.5% (3/8; 95% CI 12.1–64.6%).

Within the oncologic population, the sensitivity was 81% (13/16) and the negative predictive value was 50.0% (3/6). In the non-oncologic population the sensitivity was 75% (7/10). The differences between sensitivity and negative predictive values were not significant.

Among masses 5 cm or larger, the sensitivity of the biopsy procedures was 63.6% (7/11) and negative predictive value 20% (1/5). Among masses smaller than 5 cm, the sensitivity was 93% (13/14) and the negative predictive value was 66.6% (2/3). The difference between negative predictive value and sensitivity for large and small masses was not significant.

In patients with procedures that used only fine needles, the sensitivity was 72% (17/22) and the negative predictive value was 28.5% (2/7). When core needles were used in addition to fine needles, the sensitivity was 100% (3/3) and the negative predictive value was 100% (1/1).

Table 2 Detailed characteristics of 28 patients who underwent chest wall biopsy

Site	Mass size (cm)	Final diagnosis	Ultrasound/ CT	Needle	Oncologic patient (known prior cancer)
Right chest posterior	4.0 cm	B cell lymphoma	CT	9 cm × 22 gauge Westcott needle × 2	No
Left chest wall	3 cm	Poorly differentiated carcinoma	CT	9 cm × 22 gauge Westcott needle × 1	Breast cancer
Left chest wall	3.5 cm	Non-diagnostic	CT	10 cm × 22 gauge Westcott needle × 2	Prostate cancer
Left chest wall	4.5 cm	Dendritic cell sarcoma	CT	9 cm × 22 gauge Westcott needle × 1	Dendritic cell sarcoma
Right chest wall	4.5 cm	Extension from adenocarcinoma of lung	CT	5 cm × 22 gauge Westcott needle × 2	NSCLC
Left chest wall	3.5 cm	Metastasis from vulvar SCC	CT	9 cm × 22 gauge Westcott needle × 3	Vulvar cancer
Right chest mass	6 cm	Schwannoma	CT	9 cm × 22 gauge Westcott needle × 3	No
Right lower chest mass	5 cm	Non-diagnostic	CT	9 cm × 22 gauge Westcott needle × 2 and 18 gauge needle	Neuroblastoma
Right posterior chest mass	3.5 cm	Non-diagnostic	CT	9 cm × 22 gauge Westcott needle × 2	NSCLC
Right chest wall mass	9.0 cm	Recurrent NHL	Ultrasound	9 cm × 22 gauge Westcott needle × 2	NHL and CLL
Lower left paraspinal mass	2.5 cm	NSCLCA	CT	9 cm × 22 gauge Westcott needle × 2	No
Left chest wall	3.5 cm	Poorly differentiated carcinoma	CT	9 cm × 22 gauge Westcott needle × 2	No
Right chest wall	10.0 cm	No malignant cells, but gram-positive cocci	Ultrasound	5 cm × 20 gauge Westcott needle × 2	Breast cancer
Left anterior chest mass	3.5 cm	Poorly differentiated malignant neoplasm	CT	9 cm × 22 gauge Westcott needle × 2 and 18 gauge × 1	No
Right chest wall	4.0 cm	Atypical cells	CT	9 cm × 22 gauge Westcott needle × 2	NSCLC
Left chest mass	5.0 cm	SCC	CT	9 cm × 22 gauge Westcott needle × 1	No
Left chest mass	2.0 cm	Melanoma	Ultrasound	9 cm × 22 gauge Westcott needle × 2	Melanoma
Left paraspinal mass	12.0 cm	Atypical cells	CT	9 cm × 22 gauge Westcott needle × 2	No
Right lateral chest wall mass	4.5 cm	SCC	CT	9 cm × 22 gauge Westcott needle × 1	No
Right sternal mass	4.0 cm	Metastasis from poorly differentiated breast carcinoma	CT	9 cm × 22 gauge Westcott needle × 2	Breast cancer
Right chest wall mass	7.0 cm	Non-diagnostic	CT	9 cm × 22 gauge Westcott needle × 2	No
Right posterior rib	5.0 cm	NSCLCA	CT	15 cm × 22 gauge Westcott needle × 2	NSCLC
Right posterior wall mass	7.5 cm	Non-diagnostic	CT	15 cm × 22 gauge Westcott needle × 3	SCC of the esophagus
Right soft tissues anterior to sterno-clavicular joint	5.5 cm	Gram-positive cocci, no malignant cells	CT	5 cm × 22 gauge Westcott needle × 2	Breast cancer
Left chest wall	5.0 cm	Atypical	CT	5 cm × 22 gauge Westcott needle × 2	Germ cell tumor
Right chest wall mass	1.5 cm	B cell NHL	CT	5 cm × 22 gauge Westcott needle × 2	Lymphoma
Left posterior chest wall mass	13 cm	Desmoid tumor	Ultrasound	9 cm × 22 gauge Westcott needle × 2 and 18 gauge × 1	Breast cancer
Left anterior chest wall mass	4 cm	Metastatic lung cancer	CT	9 cm × 22 gauge Westcott needle × 2 and 18 gauge × 2	Lung cancer

CLL, chronic lymphocytic leukemia; NHL, non-Hodgkin lymphoma; NSCLC, non-small cell lung cancer; SCC, squamous cell carcinoma.

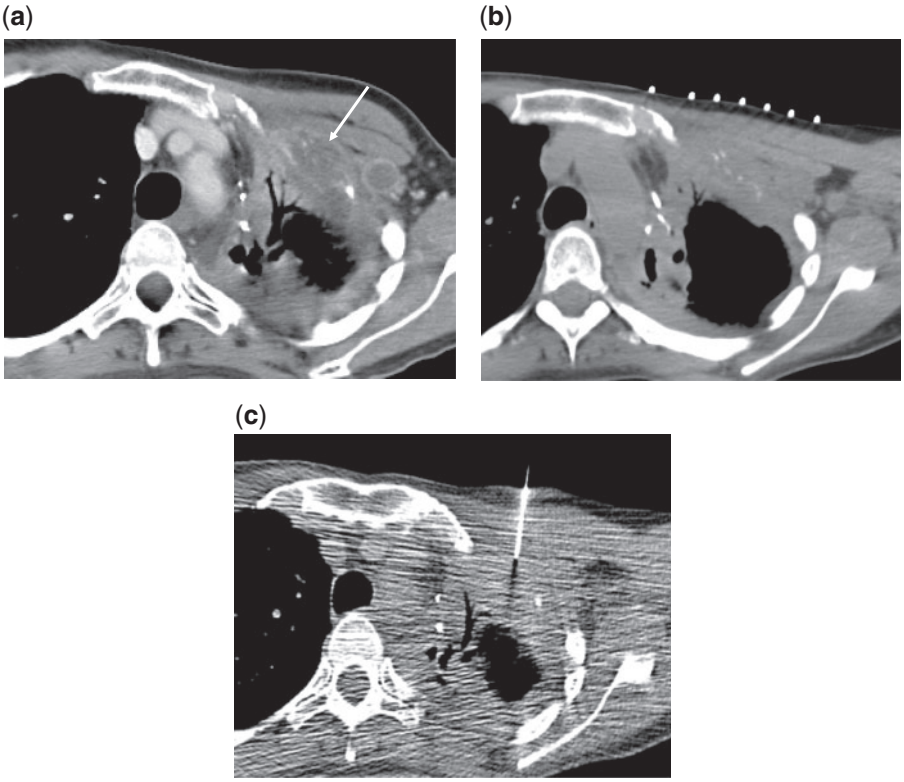

Figure 2 **A 55-year-old woman with a history of lung cancer and previous radiation therapy who presented with axillary lymphadenopathy and an infiltrative soft tissue mass involving the left anterior chest wall. (a,b) Contrast-enhanced CT scan reveals an enhancing infiltrative soft tissue mass involving the left anterior chest wall (arrow). (c) Unenhanced CT scan obtained during biopsy with a 22-gauge needle (arrow); cytopathology revealed metastatic lung adenocarcinoma.**

Complications

Minor complications related to the biopsy procedure occurred in 2 (7%) patients in whom only fine needles were used. One patient developed chest pain and follow-up spiral CT performed after biopsy demonstrated a tiny area suggestive of pulmonary contusion adjacent to the inferior border of the lesion. Another patient had severe chest pain after the biopsy, requiring analgesic care, with no significant abnormality seen in the post biopsy CT scan. Both patients recovered without complications. None of our patients developed pneumothorax.

Discussion

Chest wall tumors encompass a diverse group of lesions with a wide variety of histological types. The initial evaluation of chest wall tumors includes the use of plain chest radiography to detect and localize the lesion, as well as cross-sectional imaging with CT or magnetic resonance techniques to further characterize the tumor and define its extent. However, very often, imaging studies are not definitive or fail to provide a correct diagnosis on a chest wall mass. In patients with inconclusive imaging results, histological and cytological proof is necessary. Moreover, a negative result for malignancy without a specific diagnosis of a benign lesion does not exclude the possibility of malignancy and a specific diagnosis of benign lesions usually requires histological specimens[4,5], which can be sampled effectively under CT or ultrasound guidance[6].

In our study, percutaneous chest wall mass biopsy had sensitivity of 80% for the overall population and even higher sensitivity for masses smaller than 5 cm (93%). For this reason we support the use of image-guided biopsy of chest wall masses to identify those patients who have either a primary neoplasm or metastatic chest wall lesion. However, in our study we also had 5 patients with false-negative biopsy results. Therefore, the low negative predictive value of our biopsy results (37.5%) for the overall population implies that when a non-diagnostic result is rendered after image-guided percutaneous biopsy of a chest wall mass, either repeated biopsy or surgery should be considered.

Chest wall masses in patients with a history of cancer most likely represent metastasis from the patient's known primary cancer (10/19); however, 31.5% of our patient population (6/19) with a known primary malignant neoplasm had a non-diagnostic biopsy specimen in which 3 proved malignant on subsequent surgery or repeat biopsy.

Our success rate for adequate sampling (72%) was similar to what has been reported in the literature, ranging from 72% to 100%[7,8]. However, the higher than expected percentage of malignancies in this group (68%) may have been induced by a selection bias toward performing biopsy of masses with imaging features or other clinical factors that raised the prior probability of malignancy above that of masses that did not undergo biopsy.

We found more cases of adequate sampling when, on the same session, large needles were used in addition to fine needles. Similar findings have been previously reported by Farias et al.[8] in their retrospective analysis of 97 biopsies of mediastinal lesions under CT. They compared the sensitivity and specificity of FNA biopsy versus large needle biopsies and found that better results were obtained with the second group (89.6% versus 75.5%). They also found that tissue samples obtained with large needles also resulted in more specific diagnosis than in the fine-needle group (81.3% versus 53.1%).

Our study also focused on the clinical utility of taking a biopsy from chest wall masses in patients with a known malignancy. Among 19 patients with a known malignancy, obtaining a benign-appearing soft tissue chest wall mass had a low negative predictive value (50%). The negative predictive value was higher in the group with masses smaller than 5 cm than with masses larger than 5 cm. False-negative results after percutaneous image-guided biopsy of chest wall masses larger than 5 cm may have resulted from sampling necrotic portions of the tumor, which are typically located centrally instead of getting tissue from the rim of the mass. Kim et al.[9] have already described this problem during percutaneous biopsy of metastatic gastrointestinal stromal tumors.

FNA biopsy is acquired using 19–25 gauge needles and provides samples for cytological examination, whereas large needle biopsies are acquired using 18 gauge needles or larger and provide tissue for histological assessment[10]. FNA biopsy is preferred for sampling masses adjacent to major vessels[10] or masses that imply a greater risk of pneumothorax. Cytological samples can be rapidly stained and examined providing assessment of adequacy while the patient is still in the procedure room[11].

All 5 false-negative results in our study were obtained from biopsies taken with only fine needles. Our series showed that the sensitivity of FNA biopsy (77%) was good for most masses. When core needles were used in addition to fine needles, the sensitivity was 100% (3/3).

Stewart et al.[10] compared FNA cytology and large needle biopsy in the diagnosis of radiologically detected abdominal lesions in a series of 141 patients and found that large needle biopsy had higher sensitivity and was also more successful than FNA biopsy in subtyping tumors in a small number of cases.

There are limitations to our study. The first limitation is the relatively small size of our cohort. Second, we analyzed our data retrospectively. We also found that in two patients with benign biopsy results and one with a non-diagnostic result, the outcome was defined using clinical follow-up alone because tissue diagnosis was not obtained.

In summary, our experience indicates that image-guided biopsy of chest wall masses is useful in clinical practice and allows patients with known primary cancers who develop chest wall metastases to be treated with confidence. It also identifies specifically benign lesions in oncologic patients who are under increased risk for development of malignancy, which, without a biopsy, would have been treated incorrectly.

Percutaneous image-guided biopsy can be performed effectively with fine needles or even better when large needles are also used. If a cytotechnologist is present during the procedure, we recommend using fine needles initially, then additional large needles if the preliminary impression is nondiagnostic. As most chest wall masses are malignant, when a nondiagnostic result is obtained, repeat percutaneous biopsy or surgery should be performed.

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